

UNIVERSITY OF LJUBLJANA  
FACULTY OF ECONOMICS

MASTER THESIS

**TRANSDISCIPLINARY SUSTAINABLE DEVELOPMENT**

**(TRANSDISCIPLINARNI TRAJNOSTNI RAZVOJ)**

## IZJAVA O AVTORSTVU

Spodaj podpisani Janez Cerar, študent Ekonomske fakultete Univerze v Ljubljani, izjavljam, da sem avtor magistrskega dela z naslovom Transdisciplinarni trajnostni razvoj, pripravljenega v sodelovanju s svetovalcem prof. dr. Bogomirjem Kovačem.

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## INTRODUCTION

The introductory section is comprised of four parts: the problem description, the purpose and the hypotheses formulation, the methodology description, and the structure of the master thesis.

**Problem description.** The global economy is nowadays so large that it already goes beyond the limits of the ecosystem and even social system. New ways of thinking are required in order to develop an economy that can be sustained within the finite biosphere and which would be accepted within social structures. Since sustainable development (hereinafter: SD) is a systems problem, it logically needs a systems solution, and it cannot be derived from a single specific discipline (e.g. economy).

If there was a supercomputer into which one could load all the knowledge from all existing disciplines, than this supercomputer would be capable of knowing everything while understanding nothing. A user of such computer would have immediate access to any results (content) from any discipline, but would be incapable of understanding their meanings. The meaning is hidden in connections between the different disciplines, with other words, each discipline gives other discipline a meaning and consequently also a new content. In this context SD needs understanding of such meanings in order to solve systems problems. Such a complex holistic view is a key topic that is discussed especially in the first section of the master thesis.

Main current SD global problems, like uneven income distribution (poverty and new era slavery), unemployment, overpopulation, neo-imperialism, forced migrations, destruction of ecosystems, governance (neo-liberalism), lack of human development vision, enforced destructive way of living, etc., cannot be adequately tackled from the content of specific individual disciplines. These problems include not only some of the environmental issues (broadly known as climate change and biodiversity loss), but mostly social issues.

In a world characterized by such complex problems, uncertainty, and increasing interconnectedness, there is a growing need for science to contribute to the solution of problems. Up till now, progress in finding solutions has been very slow (Hadorn, Bradley, Pohl, Rist & Wiesmann, 2008, p. vii). Nevertheless, the SD issues indeed constitute the most dangerous and difficult challenge that humanity has ever faced (Heilbroner, 1970, p. 270). In December 2002, the United Nations General Assembly, through its Resolution 57/254, proclaimed the years from 2005 to 2014 the Decade of Education for SD (hereinafter: DESD). Governments from around the world have been invited to strengthen their contribution to sustainability through a focus on education. It also designated UNESCO as the lead agency for the promotion of this decade (UNESCO, 2011).

Unsustainable development leaves behind large areas of poverty, stagnation, marginality, and destruction of the natural environment (United Nations, 1971). The public is becoming increasingly aware that the usual political and economic mechanisms are hardly in a position to provide solutions to such hybrid problems. Developing a readiness to deal constructively with a necessary openness to new approaches is a leading challenge facing society today. A demand for

deep and fundamental change, however, stands in conflict with the continued practice of the industrial development model (The Institute for Social-Ecological Research, 2011). Summing up, mainstream “green reformism” is paradoxically trying to save capitalism from collapse. Faced with such a situation, development of an ability to deal with transformations is critically needed.

**Purpose and hypotheses of the master thesis.** Responsibility towards future and present generations generally implies a responsibility to acquire knowledge. How to establish an environment where complex SD questions could be answered and where appropriate knowledge would be developed? To answer this question is the fundamental goal of the master thesis. I do not try to answer complex questions regarding operationalization of SD, but I rather try to answer the question: under what circumstances, i.e., conditions, could applicable SD questions be solved? Master thesis ideas and understandings might be useful to governmental and nongovernmental environmental organizations, regional development agencies, the academic sphere, and others.

A contribution to a holistic understanding of SD and an introduction of the concept of transdisciplinarity (hereinafter: TD<sup>1</sup>) to Slovenian academic environment is a big challenge. The key goal of the **basic research** in the first section is to integrate SD with the concept of TD and to clarify the notion of the concept of human value in relation to the concept of TD. Last but not least, the goal is also to prepare a glossary of new key terms and translate them in Slovene language and by this, introduce them into Slovenian science.

The purpose of the empirical section, i.e., **applied research**, is to find TD institutions around the world and to find out whether these TD institutions operate according to the principles of TD foundation. The focus is on the SD field, while not excluding other areas of science. A fundamental goal is to select institutions which best suit the definition of TD and to find out which factors importantly influence the degree of TD integration. The hypotheses are listed below:

**Hypothesis 1:** Most TD institutions were recently established and there is an upward trend in the establishment of institutions.

**Hypothesis 2:** The main activity of TD institutions is research and much less education.

**Hypothesis 3:** More than half of the TD institutions are located in North America, fewer in Europe and even fewer in Asia and Australia.

**Hypothesis 4:** Because TD is in nascent phase of development, institutions implement TD approach in various ways. Less than one quarter of TD institutions fully adopt and implement the concept of TD introduced in the first section of the master thesis.

**Hypothesis 5:** A strong correlation between SD institutions with the concept of TD exists. Institutions directly related to SD predominantly use a holistic TD approach that integrates economy, ecosphere, and sociosphere. In such institutions the concept of TD is the most consistently applied, unlike in other institutions that are indirectly related to SD.

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<sup>1</sup> **TD** – An abbreviation for transdisciplinarity or/and transdisciplinary.

According to the hypotheses above I have found a lot of literature and sources to scientifically argue the holistic perception of SD from TD angles of view.

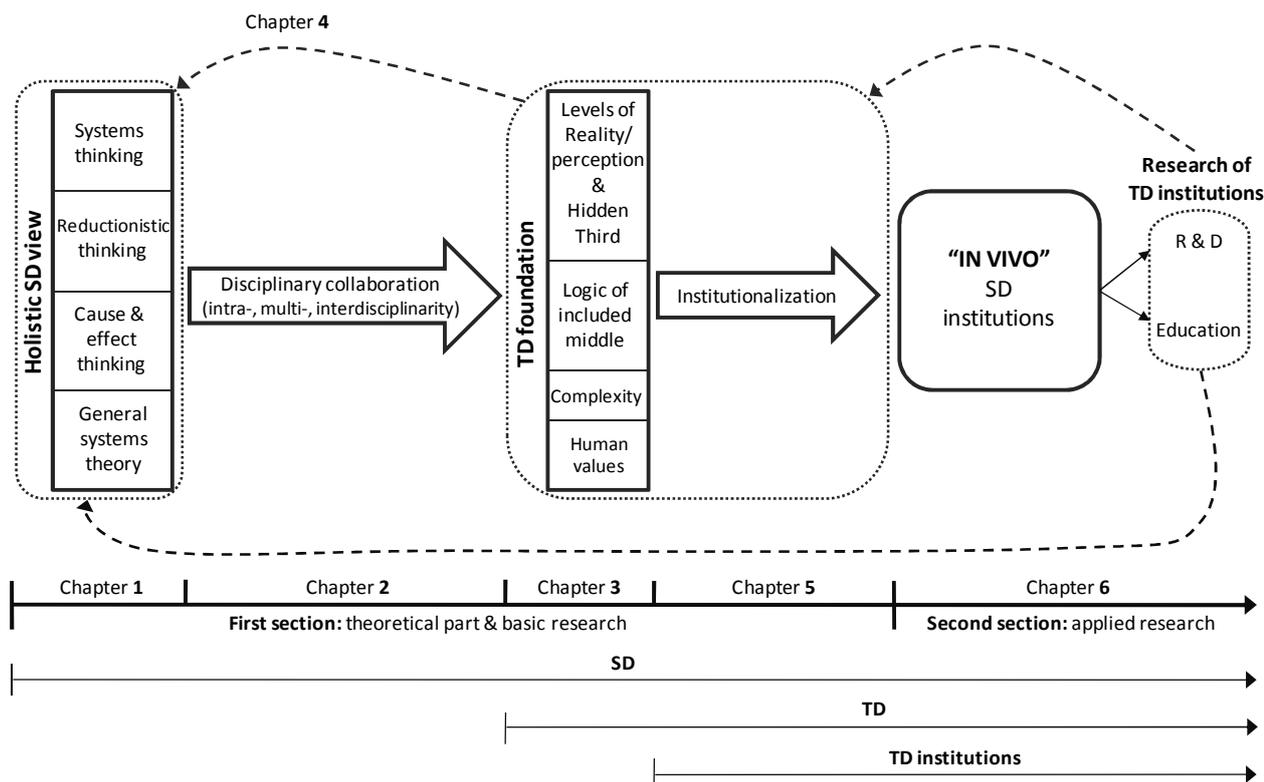
**Methodology.** In the theoretical part, literature review (summary) is the first method where I collect relevant scientific papers and other literature/sources to find and discuss definitions of different concepts and phenomenon, such as SD, complexity, systems thinking, reductionistic and cause-and-effect thinking, general systems theory, interdisciplinarity, TD, holism, level of Reality, the logic of included middle, human values, etc. This section highlights SD from a holistic point of view and explains the complex, systemic nature of SD. In parallel to this, there is discussed how to deal with such complexity and how holistic supporting knowledge can be created. Afterwards follows basic research with my contributions to a holistic understanding of SD. By using intuition, creativity, and imagination, I integrate SD with the concept of TD. Moreover, I also integrate concept of human value in the concept of TD. Institutionalization of the concept of TD is highlighted at the end of the first section.

The basic research lays down the foundation for the applied research. Combination of a qualitative and quantitative approach is used as the research method in the empirical part, i.e., applied research (second section). The predominant research method is the qualitative interpretative research method; but, to analyze qualitative data, I use also quantitative approach in order to represent data in the graphic figures. To present research findings, I use the critical interpretive synthesis method. However, studies provide a useful review of several institution's approaches towards the concept of TD.

**Master thesis structure.** The content of the master thesis and its structure are characterized by the holism, reciprocity, feedback loops and dynamics. In other words, the structure is designed to follow the content. The structure frame consists of six main chapters. SD from a holistic and systemic perspective is introduced in **Chapter 1**. Some general theoretical basis is presented in the context of complexity and systems thinking, reductionistic and cause and effect thinking, and finally general systems theory.

**Chapter 2** is dedicated to the introduction of modes of disciplinary collaboration, i.e., intradisciplinarity, multidisciplinarity, interdisciplinarity, and TD. The last also presents an introduction to the next **Chapter 3** where the foundation of TD is discussed. The four pillars of TD are introduced including multiple levels of Reality, the logic of the included middle, the complexity of knowledge, and the integral human values. The concept of human values, including their structure, is here more thoroughly analyzed; this could be considered as my contribution to TD evolution as well as integrating SD with the concept of TD (**Chapter 4**). With my views I indicate a new holistic way how the two concepts can get closer to each other. Chapter 4 concludes with highlighting of the United Nation (hereinafter: UN) decade of education for SD.

Figure 1: Structure of the master thesis



The introduction to the second section is formulated in **Chapter 5**. The main topics here are the institutionalization of the concept of TD, including TD views of academic/research institutions, evaluating quality of TD research, and analysis of barriers to TD collaboration. Finally, in **Chapter 6** the key findings of research of TD institutions are analyzed and discussed. At the end of the master thesis, final thoughts and relevant appendices can be found.

## 1 SD FROM A HOLISTIC SYSTEMS PERSPECTIVE

SD means different things to different people. There are many reasons for this. To begin with, the concept of SD is used in many locations and contexts, by people from varying cultural backgrounds and disciplinary schools of thought, and for different purposes. Second, the concept of SD has evolved rapidly and over a relatively short period of time. Finally, debates about SD have been influenced by a wide range of underlying views regarding the relationship between human beings, economic systems, and the natural environment of which they are a part. As such, there are various opinions as to how SD should be measured and what is required to move toward the SD goal (Lawn, 2006, p. 13). Eventually, definition of SD is directly dependent to the specific context being observed, whether it concerns development of a certain country, region, firm, institution, etc.

In the broadest sense and for the purpose of SD definition there should be all the dimensions of human being understood and treated simultaneously and equally (Baumgärtner & Quaas, 2010):

1. Homo **biologicus**: how and to what extent is the human being as a biological being determined by, and dependent upon, nature?
2. Homo **oeconomicus**: how and to what extent does an individually acting human being follow its self-interest?
3. Homo **sociologicus**: how and to what extent is a human individual determined by, and dependent upon, social relationships?
4. Homo **ecologicus**: how and to what extent is a human being characterized by its relationship to nature?
5. Homo **politicus**: how and to what extent does a human being act on behalf of a community as a citizen or politician with an orientation towards justice?

In the following chapters I try to find explanation to the question: “How can we better understand the relationships between these different dimensions of human being, and under what conditions is it feasible?”

SD, as a concept, in the first place incorporates the ethical dimension. Sustainability aims at justice in the domain of human – nature relationships and in view of the long-term and inherently uncertain future. This includes three important relationships (Becker, 2009, p. 23):

1. **Intergenerational justice**: justice between humans of different generations;
2. **Intragenerational justice**: justice between different humans of the same generation, in particular the present generation;
3. **Physiocentric ethics**: justice between humans and nature.

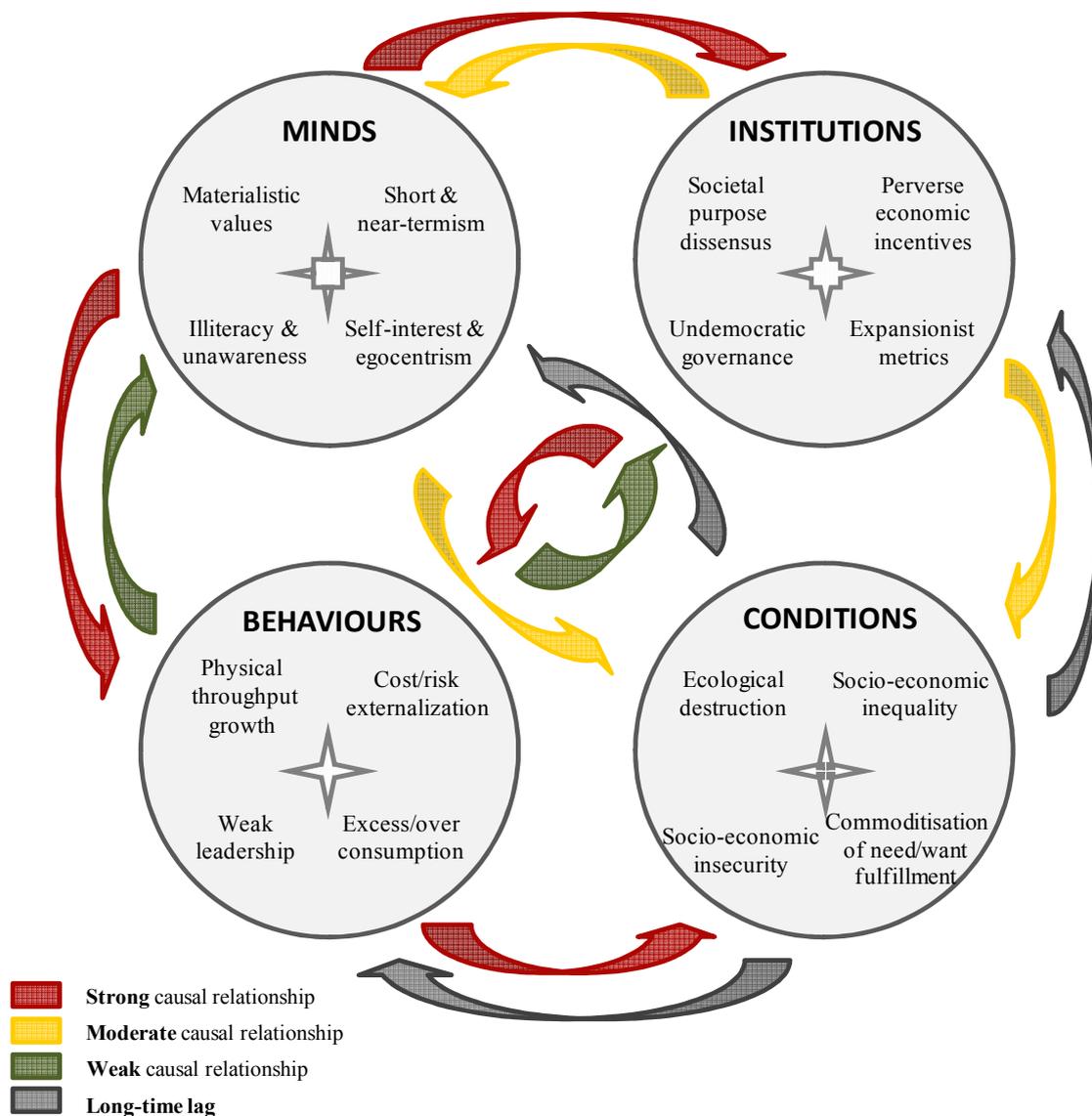
Aspects of intergenerational and intragenerational justice, for instance, are expressed in the widely accepted definition given by the Brundtland-Commission (WCED, 1987, p. 43): “SD is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.” While intergenerational and intragenerational justice reflects an anthropocentric idea of justice, SD also includes physiocentric ethics aspect, i.e., the idea of justice towards nature for its intrinsic value (DesJardins, 2005). This interpretation of SD implies nature conservation for its own sake.

One needs to be aware that besides SD (justice in domain of human – nature relationships) there exist other legitimate societal goals, including goals of justice in other specific areas of human life, e.g. labor or education. While justice is the normative foundation of sustainability, neoclassical economics is aimed at the normative goal of an ever better satisfaction of human individual needs and wants (Hausman & McPherson, 2006). It is quite hard to accept this position and take the satisfaction of individual human needs and wants to be a legitimate normative goal that may stand on equal footing with other normative goals such as sustainability or justice in general.

Until now, there have been changes only on relation economy – nature, but necessary changes on the level of human system structures were systematically ignored. The structural problem of capitalism is that it creates an unprecedented social material wealth (big material potential), but

at the same time destroys it. With other words, capital creates material value (merchandise) with the purpose to destroy (consume) it (Žižek, 2009). Capitalism perceives maximization of satisfaction through maximization of consumption, but on the other side ecology perceives maximization of consumption as a force that moves world balance to the edge.

Figure 2: Current failings of the economy: cause and effect relationships



Source: University of Cambridge, 2011.

We have collectively and systemically invented and adopted neoliberal capitalism, but we are still caught up in the dilemma described by John Maynard Keynes many years ago (year 1933): “Capitalism is not a success. It is not intelligent, it is not beautiful, it is not just, it is not virtuous – and it does not deliver the goods. In short, we dislike it, and we are beginning to despise it. But when we wonder what to put in its place, we are extremely perplexed.” The challenge of SD is the central challenge of our time. Great wisdom is needed to realize how to transform capitalism which is possibly the largest, most self-reinforcing, and most seductive and addictive system ever invented (University of Cambridge, 2011). It is quite surprising, that people can easier

imagine the end of the world than the end of capitalism. With other words, it is easier for them to imagine the end of infinity (world-cosmos) than the end of finiteness (capitalism). They are not aware of discontinuity of capitalism. Finiteness is only one small particle of the infinity.

The Figure 3 shows current failings of the economy with the cause and effect relationships. One of the key findings is that the human values underlying the current economic system may be incompatible with the principles of SD. Today, people's minds (TD Subject – consciousness, perception, cognition) are considered as largest source of materialistic values, short & near-termism, illiteracy & unawareness and also self-interest & egocentrism. Consequently, these human pitfalls have their effects to other failings such as human behaviors (physical throughput growth, weak leadership, cost/risk externalization, over consumption), position of institutions in society (perverse economic incentives, expansionistic metrics, undemocratic government, societal purpose dissension) and other conditions (socio-economic insecurity, ecological destruction, commoditization of need/want fulfillment, socio-economic inequality).

**Capitalism is a system that supports or even rewards human weakness** such as selfishness, greed, corruptiveness as well as prejudice, egoism, individualism, willful denial of knowledge, wrong value system, etc. It creates and develops human relations and relationships in accordance to a Latin phrase “**Homo homini lupus est**” which means “**man is a wolf to man (or his fellow)**”. SD remains the only seriously “big idea” that underpin Apollonian values (see Chapter 3.4.1) such as interdependence, empathy, equity, personal responsibility and intergenerational justice. They are the only foundation upon which any feasible vision of a better sustainable world can be constructed (University of Cambridge, 2011).

In this modern economics, it remains open what the “ends” of needs and wants satisfaction are to be. It seems that SD deals with joint problems of efficiency and justice. In this interpretation, “what most distinguishes economics as a discipline is not its subject matter, but its approach with the assumption of maximizing behavior” (Becker, 1978, p. 5).

Anyway, the purpose of the master thesis is not focusing on definitions of SD; I rather depict necessary conditions to find holistic systems solutions to SD challenges. In science systems, it is argued that the only way to fully understand why a problem or an element occurs and persists is to understand the parts in relation to the whole (Capra, 1996, p. 30). Standing in contrast to Descartes' scientific reductionism<sup>2</sup> and philosophical analysis, it proposes to view systems in a holistic manner. Consistent with systems philosophy, systems thinking concerns an understanding of a system by examining the linkages and interactions between the elements that compose the entirety of the system (Systems thinking, 2011).

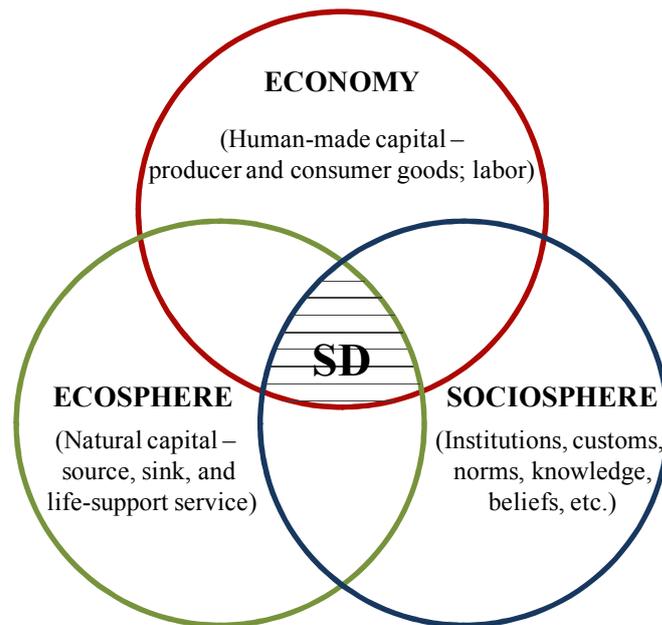
According to systems philosophy, there are no “systems” in nature. The universe, the world and nature have no ability to describe themselves. That which is, is. With respect to nature,

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<sup>2</sup> **Reductionism** can either mean (a) an approach to understanding the nature of complex things by reducing them to the interactions of their parts, or to simpler or more fundamental things or (b) a philosophical position that a complex system is nothing but the sum of its parts, and that an account of it can be reduced to accounts of individual constituents (Reductionism, 2011).

conceptual systems are merely models that humans create in an attempt to understand the environment in which they live. The system model is used because it more accurately describes the observations (Laszlo, 1972a). Because systems are models created only for understanding, the most fundamental property of any system is that a system has an arbitrary boundary. Humans create the boundaries to suit their own purposes of analysis, discussion and understanding. This is true of every conceptual model that was devised through which humans try to understand the universe (Laszlo, 1972b).

*Figure 3: A mechanistic relationship between economy, sociosphere, and ecosphere*



*Source: P. A. Lawn, Sustainable development indicators in ecological economics, 2006, p. 14.*

Unfortunately, a number of past interpretations of SD have been falsely assumed that ecological, social and economic spheres are independent systems. The circular flow model that forms the centerpiece of the mainstream economic view of the SD process is a case in point. The inadequacy of this approach has led many observers to introduce linkages between the three major systems (see Figure 2) (Mulder & van den Bergh, 2001).

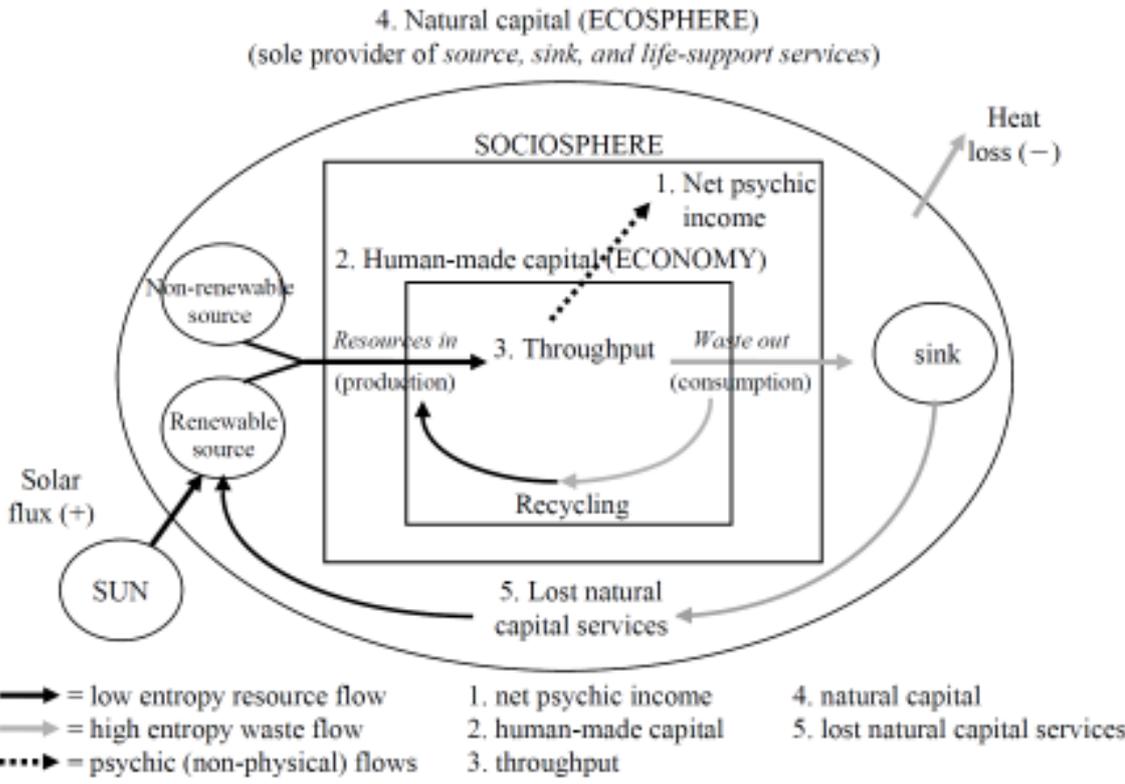
## 1.1 Complexity and Systems Thinking

W.R. Ashby (1973), one of the fathers of modern systems thinking, defined complexity as the quantity of information required to describe something. This includes the number of parts and their interrelations that make up that “whole”. Complexity is thus in the eye of the beholder. It seems that the more we know about something, the more complex we see it. The same is true for decision making. Hand-in-hand with the accelerating rate of innovation in technology and communications has been the ever increasing complexity of various large infrastructures that regulate our daily lives. Today’s world has increased in complexity and interdependence to a point where the traditional methods of problem solving based on the cause-and-effect model cannot cope any longer (Daellenbach & McNickle 2005, pp. 10–11).

With systems we can look at the connections between elements, at new properties that emerge from these connections and feedbacks, and at the relationships between the whole and the part. This worldview is referred to as “systems thinking.” (Voinov, 2008, p. 25).

The roots of systems thinking go back to studies on systems dynamics led by Jay Forrester, who was also the inventor of the random access memory used in all computers today. Even though back in 1956 he never mentioned systems thinking as a concept, the models he was building clearly developed the niche that would be then filled by the holistic, integrative, cross-disciplinary analysis. With his background in electrical and computer engineering, Forrester has successfully applied some of the same engineering principles to social, economic and environmental problems. The main idea is to focus on the system as a whole (see Figure 4 and 37). Instead of traditional analytical methods, when in order to study we disintegrate, dig inside and study how parts work, now the focus is on studying how the whole works, how the parts work together, what the functions are, and what the drivers and feedbacks are (Voinov, 2008, pp. 25–26).

Figure 4: Interdependent relationships between the economy, sociosphere, and ecosphere



Source: P. A. Lawn, Sustainable development indicators in ecological economics, 2006, p. 14.

In Figure 4 each sphere can be considered a holon, as they manifest the independent and autonomous properties of wholes and the dependent properties of parts. Thus, each sphere consists of smaller parts while simultaneously acting as the part of a larger whole (e.g., the macroeconomy serves as a component of the sociosphere while the sociosphere serves as a component of the ecosphere). In a sense, Figure 4 represents the sociosphere as the interfacial system between the macroeconomy and the larger ecosphere, thereby highlighting the crucial

role played by institutions and social capital in promoting stable SD. Science systems thinkers consider that (Capra, 1982; Faber et al., 1992; Hodgson, 1988):

- a system is a dynamic and complex whole, interacting as a structured functional unit;
- energy, material and information flow among the different elements that compose the system;
- a system is a community situated within an environment;
- energy, material and information flow from and to the surrounding environment via semi-permeable membranes or boundaries;
- systems are often composed of entities seeking equilibrium, but can exhibit oscillating, chaotic, or exponential behavior.

A holistic system is any set, i.e., group, of interdependent or temporally interacting parts. Parts are generally systems themselves and are composed of other parts, just as systems are generally parts or **holons**<sup>3</sup> of other systems. The systems thinking approach incorporates several tenets (Skyttner, 2006):

- **Interdependence of objects and their attributes** – independent elements can never constitute a system;
- **Holism** – system is viewed as wholes, not as collections of parts;
- **Inputs and Outputs** – in a closed system inputs are determined once and constant; in an open system additional inputs are admitted from the environment;
- **Transformation of inputs into outputs** – this is a process by which the goals are obtained;
- **Entropy** – the amount of disorder or randomness present in any system;
- **Regulation** – a method of feedback is necessary for the system to operate predictably;
- **Hierarchy** – complex wholes are made up of smaller subsystems;
- **Differentiation** – specialized units perform specialized functions;
- **Equifinality** – alternative ways of attaining the same objectives (convergence);
- **Multifinality** – attaining alternative objectives from the same inputs (divergence).

As an aspect of systems theory, **system dynamics** is a method for understanding the dynamic behavior of complex systems. The basis of the method is the recognition that the structure of any system is often just as important in determining its behavior as the individual components themselves. Examples are chaos theory and social dynamics. It is also claimed that, in many cases the behavior of the whole cannot be explained in terms of the behavior of the parts (Systems theory, 2011).

Systems thinking has been defined as an approach to problem solving, by viewing problems as parts of an overall system, rather than reacting to specific part, outcomes or events and potentially contributing to further development of unintended consequences. Systems thinking is a set of habits or practices (Waters foundation, 2011) within a framework that is based on the

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<sup>3</sup> A **holon** is a term made popular by Arthur Koestler. It is something that is simultaneously a whole and a part. Koestler proposed the word holon to describe the hybrid nature of sub-wholes and parts within “IN VIVO” systems. From this perspective, holons exist simultaneously as self-contained wholes in relation to their sub-ordinate parts, and dependent parts when considered from the inverse direction.

belief that the component parts of a system can best be understood in the context of **relationships with each other and with other systems, rather than in isolation**. Systems thinking focuses on cyclical rather than linear cause and effect. In nature, systems thinking examples include ecosystems in which various elements such as air, water, movement, plants, and animals work together to survive (Systems thinking, 2011).

Large-scale, complex problems include not only the design of engineering systems with numerous components and subsystems which interact in multiple and intricate ways; they also involve the design, redesign and interaction of social, political, managerial, commercial, religious, biological, medical, etc. systems. Further, these systems are likely to be dynamic and adaptive in nature. Solutions to such large-scale, complex problems require many activities which cross discipline boundaries. One needs to consider that economy is seen as an isolated, open sub-system of a larger eco-system. The larger eco-system is finite, non-growing and materially closed. As a result of such thinking, new insights can be gained into how the concept of SD works, why it has problems, how it can be improved or how changes made to one component of the system may impact the other components.

## 1.2 Reductionistic and Cause-and-Effect Thinking

Responsible decision making must consider the undesirable and/or additional beneficial effects of unplanned outcomes on the system as a whole. A comprehensive systems analysis is more likely to uncover most of the unplanned outcomes than a narrow cause-and-effect analysis (Daellenbach & McNickle, 2005, p. 15).

Russell L. Ackoff<sup>4</sup> says that the foundations of the traditional scientific model of thoughts are based on two major ideas. **The first is reductionism:** the belief that everything in the world and every experience of it can be reduced, decomposed, or disassembled into ultimately simple indivisible parts. Explaining the behavior of these parts and then aggregating these partial explanations is assumed to be sufficient to allow us to understand and explain the behavior of the system as a whole. Applied to problem solving, this translates into breaking a problem into a set of simpler sub-problems, solving each individually and then assembling their solutions into an overall solution for the whole problem (Daellenbach & McNickle, 2005, pp. 17–18).

**The second basic idea is that all phenomena are explainable by using cause-and-effect relationships.** A thing X is taken to be the cause of Y, if X is both necessary and sufficient for Y to happen. Hence, “cause X” is all that is needed to explain “effect Y”. If we view the world in this way, everything can be explained by decomposing it into parts and looking for cause-and-effect relationships between the parts. But it may be inadequate to examine the causal relationships one by one. New relationships or properties may emerge through the interaction between the various parts or aspects of a situation. Some of these are usually planned, while

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<sup>4</sup> **Russell Lincoln Ackoff** (February 12, 1919 – October 29, 2009) was an American organizational theorist, consultant, philosopher, operations researcher and Anheuser-Busch Professor Emeritus of Management Science at the Wharton School, University of Pennsylvania. Ackoff was a pioneer in the field of operations research, systems thinking and management science (Ackoff, 2011).

others may be unexpected and counterintuitive. Furthermore, causal relationships may not be simply one-way. There could be mutual causality (see Glossary) or feedback between two things, that is, X affects Y, but is in turn affected by Y. The two are interdependent. Dealing with one alone, while ignoring the other, may not achieve the desired results (Daellenbach & McNickle, 2005, p. 18).

A systemic view on organizations is TD and integrative. In other words, it transcends the perspectives of individual disciplines, integrating them on the basis of a common “code”. The systems approach gives primacy to the interrelationships, not to the elements of the system. It is from these dynamic interrelationships that new properties of the system emerge. In recent years, systems thinking has been developed to provide techniques for studying systems in holistic ways to supplement traditional reductionistic methods (Systems theory, 2011).

### 1.3 General Systems Theory

Systems theory is the TD study of systems in general, with the goal of elucidating principles that can be applied to all types of systems in all fields of research. The term does not yet have a well-established, precise meaning, but systems theory can reasonably be considered a specialization of systems thinking and a generalization of systems science. The term originates from Bertalanffy’s General System Theory (hereinafter: GST). In this context the word “systems” is used to refer specifically to self-regulating systems, which are self-correcting through feedback. Self-regulating systems are found in nature, including the physiological systems of our body, in local and global ecosystems, and in climate (Systems theory, 2011).

In Boulding’s mind GST was to be a tool that would enable humankind to effectively move back and forth between the perfectly describable Platonic world of theory and the fuzzy world of practice. Boulding points out that any claims to any sort of theory of everything are misguided as “such theory would be almost without content, for we always pay for generality by sacrificing content, and all we can say about practically everything is almost nothing” (Richardson, 2004). **Somewhere, however, between the specific that has no meaning and the general that has no content there must be an optimum degree of generality** (Boulding, 1956).

The more science breaks into sub-groups, and the less communication is possible among disciplines the greater chance there is that the total growth of knowledge is being slowed down. The spread of “specialized deafness” means that someone who ought to know something that someone else knows is not able to find it out for lack of **generalized ears**. It is one of the main objectives of GST to develop these generalized ears, and by developing a framework of general theory to enable one specialist to catch relevant communications from others (Boulding, 1956).

Many of the economic theoretical models and frameworks do not come out of “economic theory” as this is usually taught, but from sociology, social psychology, and cultural anthropology. Students in the department of economics, however, rarely get chance to become acquainted with these theoretical models, which may be relevant to their studies, and they become impatient with economic theory, much of which may not be relevant (Boulding, 1956).

Phenomenon of almost universal significance for all disciplines is that of the interaction of an “individual” of some kind with environment. Every discipline studies some sort of “individual” – electron, atom, molecule, virus, cell, plant, animal, man, tribe, church, firm, corporation, etc. Each of these individuals exhibits behavior, action, or change, and this behavior is considered to be related in some way to the environment of the individual, i.e., with other individuals with which it comes in to relation or into some relationship. **The behavior of each individual** is explained by the structure and arrangement of the lower individuals of which it is composed (Boulding, 1956).

**GST is the skeleton of science** in the sense that it aims to provide framework or structure of systems on which to hang particular subject matters in an orderly and coherent corpus of knowledge. It is also, however, the “cupboard” in the case being the unwillingness of science to admit the very low level of its successes in systematization, and its tendency to shut the door on problems and subject matters which do not fit easily into simple mechanical schemes (Boulding, 1956).

Boulding’s GST is a sort of manifesto for the systems movement, much of which can be seen to be valid for complex systems theory today. A major role for GST was to facilitate communication between disparate fields of interest and, to **provide a common language** with which to discuss systemic problems. Modern complex systems thinkers share a lot of the aims and ambitions of the original general systems movement, such as the need for cross-disciplinary communication and the development of analytical tools and processes to interact with a complex (systemic) world (Richardson, 2004).

Integration of knowledge is considered as a key component in an effort to better understand today’s systems problems of all SD sub-systems, i.e., the environmental problems, economic crisis, and socio-political crisis. Unity of knowledge is not a simple task, but could be starting point for creating new knowledge for finding complex solutions for humanity in overall crisis. GST tells us that each discipline has content, but the meaning lies across the disciplinary boundaries. Modes of disciplinary collaboration are further discussed in the following section.

## **2 MODES OF DISCIPLINARY COLLABORATION**

The early Universities such as Salerno, Bologna, Oxford and Cambridge, started with faculties of medicine, philosophy, theology and law. It was around these four areas that the totality of knowledge was contained. With the passing of time, faculties became more and more specialized; thus multiple disciplines have arisen. As long ago as around the 1950’s the University of Illinois published a book that listed over 1100 known scientific disciplines, without including the humanities. Such departmentalization has been significant for the maintenance of disciplinary autonomies, for the competition of research funds, and for the consolidation of academic prestige. Professors and disciples have developed and enhanced disciplinary loyalties up to the point of frequently feeling that theirs is the most important of the entire University (Max-Neef, 2005).

When referring to the nature of theory, education, research, and knowledge generation in the academy there are several terms usually employed: intradisciplinarity, multidisciplinarity, interdisciplinarity and, more recently, TD (Schneider, 2003).

## 2.1 Intradisciplinarity, Multidisciplinarity and Interdisciplinarity

**Disciplinarity or intradisciplinarity** is about monodiscipline, which represents specialization in isolation. One person may study biology and handle it well without the need for knowledge about physics or psychology (Max-Neef, 2005).

**Multidisciplinarity** concerns studying a research topic not in just one discipline, but in several at the same time. A person may have studied more than one area of knowledge, **without making any connections** between them. For example, one may become competent in chemistry, sociology and linguistics, without generating any cooperation between the disciplines. Multidisciplinary teams of researchers are common and frequent nowadays. In them, the members carry out their analyses separately, as seen from the perspective of their individual disciplines, the final result is a series of reports added together, without any integrating synthesis (Max-Neef, 2005).

**Interdisciplinarity** concerns the transfer of methods from one discipline to another. One can distinguish three degrees of interdisciplinarity. Firstly, **degree of application**; e.g., when the methods of nuclear physics are transferred to medicine, which consequently leads to the appearance of a new treatments for cancer. Secondly, **epistemological degree**; e.g., transferring methods of formal logic to the area of general law, which generates some interesting analyses of the epistemology of law. Lastly, **degree of the generation of new disciplines**; e.g. when mathematical methods are transferred to meteorological phenomena or stock market processes, generating chaos theory. Like multidisciplinarity and interdisciplinarity overflows the disciplines, but its goal still remains within the framework of disciplinary research (Nicolescu, 2005).

In the last 30 years (since 1980) there has been increasing interest in the interdisciplinary approaches according to publications on research platform for information in the sciences, social sciences, arts, and humanities called Web of Knowledge (see Figure 35 in Appendix 2). In the year 2009 there were published more than 3000 publications that include “interdisciplinary” or “interdisciplinarity” in the topic.

## 2.2 Towards TD

TD is radically distinct from multidisciplinarity and interdisciplinarity because of its goal and the understanding of the present world, which cannot be accomplished in the framework of disciplinary research (Nicolescu, 2002). TD means to reach out beyond science and to include aspects of practical contexts and values or normative judgments (sustainability, good-practice), as well as to feed-back results into practical actions (politics, management) (Baumgärtner, Becker, Frank, Müller & Quaas, 2008, p. 387).

TD was recognized as a form of disciplinarity nearly 40 years ago at meetings about interdisciplinarity held by the Organization for Economic Cooperation and Development (OECD). In fact, the term TD appeared in academic texts as early as the 1970s (Schneider, 2003). However, there has been substantive progress in TD approaches during the past two decades (Hirsch Hadorn et al., 2008, p. vii).

As the prefix “trans” indicates, TD concerns that which is at once between the disciplines, across the different disciplines, and beyond all disciplines (Nicolescu, 2002). Its goal is the understanding of the present world, of which one of the imperatives is the unity of knowledge. The word itself is quite recent; it was introduced by Jean Piaget in 1970 (Piaget, 1972).

In contrast to interdisciplinarity, TD has more than ten times lower circulation (quantity of publications). Anyway, the number of publications, that include “transdisciplinary” or “transdisciplinarity” in the topic, grows with a high degree. The biggest number of such publication was published in year 2010 (see Figure 36 in Appendix 2).

A growing number of scientific publications is also significant in research related to SD, which concludes, that knowledge generated in science and society has become increasingly interdependent (Grunwald, 2004). One aim of TD research is to get natural and social scientists to collaborate, so as to achieve an integrated view of a subject that goes beyond the viewpoints offered by any particular discipline. TD research starts as soon as descriptive (quantitative) and interpretative (qualitative) approaches are related to each other (Pohl, 2005, p. 1163).

The Two Cultures is the title of an influential 1959 Rede Lecture<sup>5</sup> by British scientist (nuclear physicist) and novelist C. P. Snow. His basic thesis was that the breakdown of communication between the sciences and the humanities, i.e., the “two cultures”, was a major hindrance to solving the world’s problems. His view of science and the arts was formed at Cambridge in the 1930s. Any communicational problem between the arts and the sciences is now characterized by a much more general fragmentation of human learning. In particular, Snow argues that the quality of education in the world is on the decline (Snow, 2011).

The lack of communication between the two “is making it difficult or impossible for us to take good action” (Snow, 1964). By “good action” Snow meant solving the problem of unequally distributed wealth and goods on earth. His motivation for stressing the difference between the two cultures was to show that it hindered effective problem-driven research.

Although Snow did distinguish two “archetypes” of science that prevail, his distinction may seem too general today. Other concepts of disciplines have emerged that describe the characteristics of “the two” in a much more comprehensive and elaborated way, such as academic tribes and cultures (Becher, 1989). In these examples disciplines are conceived of as communities of researchers that share a particular world view, including, e.g., specific methods,

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<sup>5</sup> **The Sir Robert Rede’s Lecturer** is an annual appointment to give a public lecture at the University of Cambridge. The initial series of lectures ranges from around 1668 to around 1856. In principle, there were three lectureships each year, on Logic, Philosophy and Rhetoric. The lectures are being held also nowadays (Rede Lecture, 2011).

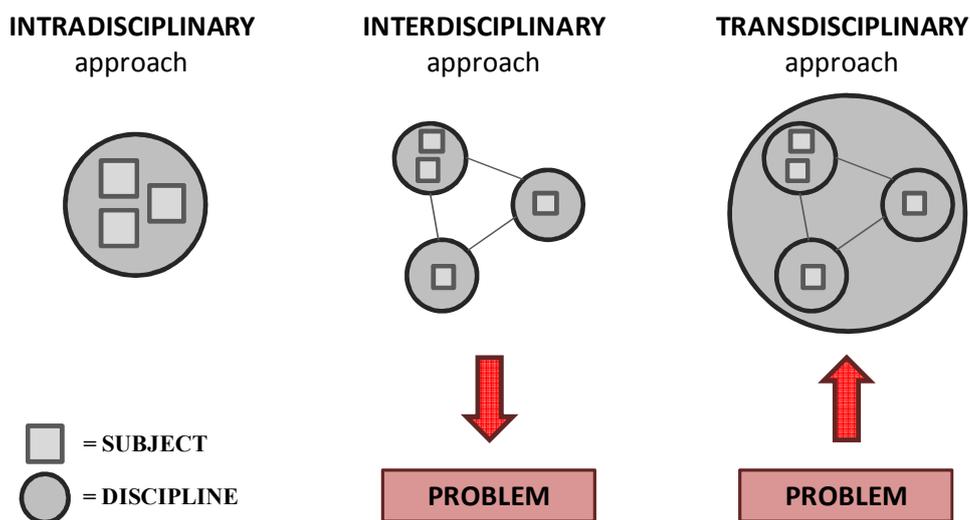
theories and common relevant problems, but also common wordings, journals, conferences and mailing lists. And there are not just two of them, but many (Pohl, 2005, p. 1163).

Along with cross-fertilization among disciplines came the recognition that there were incompatibilities among disciplines arising primarily from differences in underlying assumptions and theoretical foundations. These differences demanded knowledge unification across disciplinary boundaries. This recognition has led to the realization that we need to transcend or go beyond disciplines to fill in knowledge voids and harmonize disciplines. TD collaboration enables achieving knowledge unification across disciplines and domains. Norbert Wiener (1948) was among the first to write about growingly interconnected complex of concepts and models, and about ways of interaction among elements and organization of complex situations and systems (Madni, 2007, p. 5).

TD research is conducted by interdisciplinary teams working on a complex problem requiring expertise in different disciplines. Team member are engaged in TD thinking to fill knowledge gaps that exist among disciplines. The product of such collaboration is not merely a solution to the complex problem, but also unification of knowledge from different domains and from different disciplines. This movement towards TD research is portrayed in Figure 37 in Appendix 2 (Madni, 2007, p. 4).

As shown in Figure 5, while interdisciplinary studies start from a discipline and develop a problem around it, TD studies start from a problem and find the related disciplines which facilitate solving it. TD studies are hard to design, since they require highly prepared and motivated intellectuals (Aalborg University Copenhagen, 2011).

*Figure 5: Comparison of intra-, inter-, and TD approach*



*Source: Aalborg University Copenhagen, 2011.*

The TD knowledge (hereinafter: TK), corresponds to a new type of knowledge – “IN VIVO” knowledge. This new knowledge is concerned with the correspondence between the external

world of the Object and the internal world of the Subject. By definition, the TK includes a system of human values (see Table 1) (Nicolescu, 2005).

*Table 1: Comparison of disciplinary knowledge (DK) and TD knowledge (TK)*

<b>Knowledge DK</b>	<b>Knowledge TK</b>
“IN VITRO” <sup>6</sup>	“IN VIVO”
External world – Object	Correspondence between external world (Object) and internal world (Subject)
Knowledge	Understanding
Analytic intelligence	New type of intelligence – harmony between mind, feelings and body
Oriented towards power and possession	Oriented towards astonishment and sharing
Binary logic	Included middle logic
Exclusion of values	Inclusion of values

*Source: B. Nicolescu, Towards Transdisciplinary Education and Learning, 2005, p. 3.*

It is important to realize that the disciplinary knowledge (hereinafter: DK) and the TK are not antagonist but complementary. Both their methodologies are founded on scientific attitude (Nicolescu, 2005). In TD research issues are addressed from more than one viewpoint simultaneously. It is a means to complement the ongoing specialization of science in order to address large societal challenges (Pohl, 2005, p. 1160). These challenges are further characterized by Lawrence and Despre (2004, p. 398): “Our incapacity to deal with SD challenges [...] is related to their **complexity, to the compartmentalization of scientific and professional knowledge, to the sectoral division of responsibilities in contemporary society, and to the increasingly diverse nature of the societal contexts** in which people live”. **Our relation with a complex world and a complex nature requires complex thought.** Edgar Morin (1992) proposes a radical reformulation of our organization of knowledge, considering its increasing complexity. The idea is to develop a sort of recursive thinking<sup>7</sup>. That is to say, thinking “capable of establishing feedback loops in terms of concepts such as whole/part, order/disorder, observer/observed, system/ecosystem, in such a way that they remain simultaneously complementary and antagonistic”.

Finally, it is also worth clarifying the subtle differences between system science and TD science. One of the objectives of system science is the unification of knowledge residing in different “worlds.” In contrast, TD science is concerned with **discovering hidden connections** between different disciplines with a view to establishing a common platform for discourse among people from diverse disciplines (Madni, 2007, p. 4).

<sup>6</sup> “**IN VITRO**” (Latin “*within glass*”) refers to studies in experimental biology that are conducted using components of an organism that have been isolated from their usual biological context in order to permit a more detailed or more convenient analysis than can be done with whole organisms. In contrast, the term “**IN VIVO**” refers to work that is conducted with living organisms in their normal, intact state (In Vitro, 2011).

<sup>7</sup> **Recursiveness** – Is a general principle of transdisciplinary research. It implies that the research process has to be shaped in such a way that concepts and methods can be repeatedly tested, and that underlying assumptions can be modified if they are found to be inadequate.

### 3 FOUNDATIONS OF TD

TD represents an epistemological challenge that introduces **quantum logic, as a substitute for linear logic<sup>8</sup>, and breaks with the assumption of a single reality** (Max-Neef, 2005). While multi- and interdisciplinarity stem from classical physics and sciences, TD is based on quantum physics (see Appendix 4), chaos theory, living systems theory, consciousness sciences, and other sciences (Nicolescu, 2010). The four pillars of TD determine the methodology of TD research (Nicolescu, 2002):

- Multiple levels of Reality – the ontological axiom (see Chapter 3.1);
- The Logic of the Included Middle – the logical axiom (see Chapter 3.2);
- Complexity, complex and emergent knowledge – the epistemological axiom (see Chapter 3.3);
- Integral human values – axiology (see Chapter 3.4.1).

Epistemologically, TD recognizes the simultaneous modes of reasoning, the rational and the relational. **Transdiscipline represents a clear challenge to the binary and linear logic of Aristotelian tradition** (Nicolescu, 1998).

#### 3.1 Levels of Reality, Levels of Perception and the Hidden Third

In this section of the master thesis (except Chapter 3.4) I present more or less résumé of Nicolescu's<sup>9</sup> book titled "Manifesto of TD" published in 2002. This is fundamental book of TD roots and also of its approach to integrative knowledge where he "uses the unification of the scientific culture and the sacred as his axis to address the problem of fragmentation which plagues contemporary life". Simultaneously, there are included also elements from his paper titled "Towards TD education and learning" published in 2005 as well as some other contributions of Max-Neef, Morin, Stéphane Lupasco, and others.

For a pragmatic understanding of the different modes of thought, it is necessary to examine the first pillar of TD, namely, "levels of Reality" which absorbs many ideas from modern quantum physics and mechanics. By "**Reality**" (with a capital "R") Nicolescu designates that which resists our experiences, representations, descriptions, images, or even mathematical

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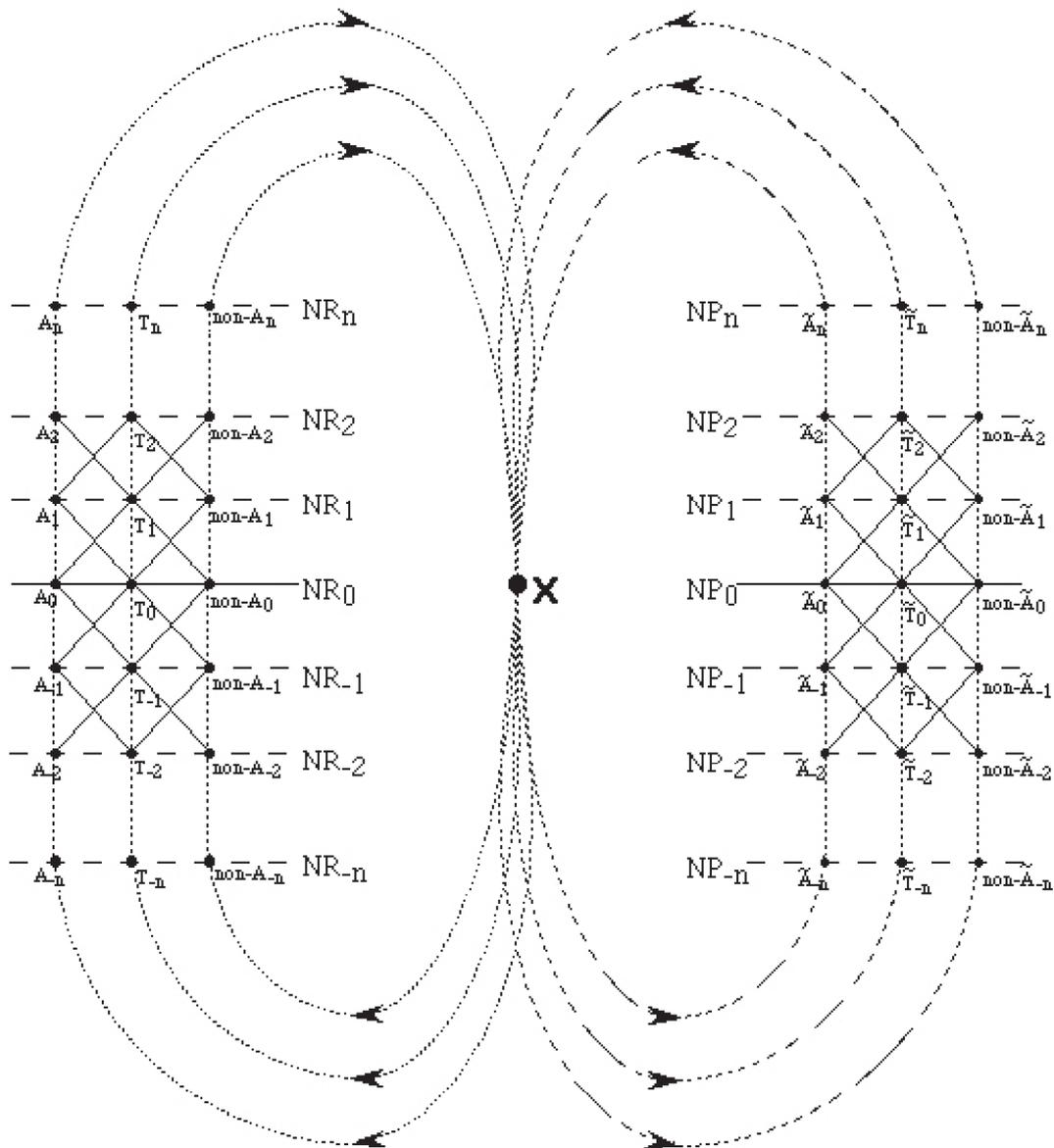
<sup>8</sup> **Linear logic** is a refinement of classical and intuitionistic logic. Instead of emphasizing truth, as in classical logic, or proof, as in intuitionistic logic, linear logic emphasizes the role of formulas as resources. Linear logic also provides new insights into the nature of proofs in both classical and intuitionistic logic. Given its focus on resources, linear logic has found many applications in Computer Science (Linear logic, 2011).

<sup>9</sup> **Basarab Nicolescu** is the president of the International Center for TD Research (hereinafter: CIRET) and Studies in Paris. He was born in 1942 in Ploiesti, Romania and received his Ph.D. at Pierre et Marie Curie University, Paris in 1972. He is a specialist in the theory of elementary particle physics. He is the author of more than a hundred articles in leading international scientific journals and has made numerous contributions to science anthologies. For many years he has collaborated with G. F. Chew, former Dean of Physics at the University of California at Berkeley and founder of the Bootstrap Theory. They have jointly published several articles on the topological framework of Bootstrap Theory. Nicolescu is a major advocate of the TD reconciliation between Science and the Humanities. Professor Nicolescu is a member of the International Society of Science and Religion (CIRET, 2011).

formulations. Nature is an immense, inexhaustible source of the unknown which justifies the very existence of science (Nicolescu, 2002).

The very core of TD approach can be described through the diagram shown on the figure below. Particularly, multiple levels of Reality (the ontological axiom) and the logic of the included middle (the logical axiom) are explained by Figure 6; it is at the same time the most relevant Figure in the theoretical part of the master thesis. It presents the TD Object, the TD Subject and the Hidden Third, which are introduced later in this chapter.

Figure 6: The TD Object, the TD Subject, and Interaction term



Source: B. Nicolescu, *Manifesto of Transdisciplinarity*, 2002, p. 155.

In the figure's left part there are symbolically drawn the levels of Reality

Levels of Reality: { NR<sub>n</sub>, ... , NR<sub>2</sub>, NR<sub>1</sub>, NR<sub>0</sub>, NR<sub>-1</sub>, NR<sub>-2</sub>, ... , NR<sub>-n</sub> }

According to the TD approach, Reality is structured via a certain number of levels which could be finite or infinite (the index  $n$  can be finite or infinite). For the sake of clarity Nicolescu supposes that this number is infinite ( $n \rightarrow \infty$  in Figure 6) (Nicolescu, 2005).

One has to distinguish the word “Real” and “Reality”. **Real** designates that what is (exists regardless of our sense organs), while **Reality** is connected to resistance in our human experience. The “Real” is, by definition, veiled forever, while the “Reality” is accessible to our knowledge (Nicolescu, 2002).

The existence of different levels of Reality has been affirmed by different traditions and civilizations. **Term “level of Reality” is designated as a group of systems which are invariant under certain laws.** Two levels of Reality are different if there is a **break in the laws and a break in fundamental concepts** (like, for example, causality) (Nicolescu, 2005). For example, economy and physics (biology) belong to very different levels of Reality.

Quantum physics reveals that quantum laws are radically differ from the laws of macrophysical world. However, no rigorous mathematical formalization has been found, to interpret the transit from one to another Reality. There are mathematical indications, however, in the sense that the **transit from the quantic world to the macro-physical world is not continuous.** The discontinuity that is manifested in the quantum world is also manifested in the structure of the levels of Reality, which means, that at least two worlds coexist. The emergence of at least three different levels of Reality in the study of natural systems (the macrophysical level, the microphysical level and the cyber-space-time) is a major event in the history of knowledge. It can lead us to reconsider our individual and social lives, to give a new interpretation to old knowledge, to explore the knowledge of ourselves in a different way (Nicolescu, 2002).

**Disciplinary research concerns, at most, one and the same level of Reality.** Moreover, in most cases, it only concerns **fragments of one level of Reality.** On the other side, TD concerns the dynamics created by the action of several levels of Reality at once. **TD is not a new discipline** or a new superdiscipline, but is nourished by disciplinary research. In turn, disciplinary research is clarified by TK in a new way. In this sense, **disciplinary and TD research are not antagonistic but complementary** (Nicolescu, 2002).

The different levels of Reality are accessible to human knowledge thanks to existence of different levels of perception, described diagrammatically at the right of Figure 6. They are found in a one-to-one correspondence with levels of Reality (Nicolescu, 2002). Such levels of perception can be activated as a consequence of different states of consciousness and they can also remain as potentials awaiting to be activated through practices as those taught by Buddhism and Taoism, i.e., by **Satori Experience**<sup>10</sup> or other means that induce altered states of consciousness (Max-Neef, 2005).

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<sup>10</sup> **Satori**, in Zen Buddhism, is the inner intuitive experience of enlightenment. It is said that Satori is inexplicable, indescribable and impossible to be understood through logic and reason. Satori is normally achieved after a concentrated period of preparation, and can happen spontaneously as a result of a sudden accidental stimuli, manifesting itself as a sudden awakening (break-through) toward a superior consciousness (Max-Neef, 2005).

Levels of perception: { NP<sub>n</sub>, ... , NP<sub>2</sub>, NP<sub>1</sub>, NP<sub>0</sub>, NP<sub>-1</sub>, NP<sub>-2</sub>, ... , NP<sub>-n</sub>}

There exists an oriented coherence of the unity of levels of Reality. If such coherence is limited only to the levels of Reality, it stops at the “highest” level and at the “lowest” level of Reality (see Figure 6). When the coherence continues beyond these two limiting levels (when there is an open unity), we must conceive the unity of levels of Reality as a unity that is extended by a **zone of nonresistance** to our experiences, representations, descriptions, images, and mathematical formulations. **In this zone of absolute transparency there are no levels of Reality.** Due to the limitations of our bodies and of our sense organs (regardless of what measuring tools are used to extend these sense organs) the **zone of absolute transparency** cannot be reached by using them. The zone is Real – that what is, while Reality is connected to resistance in our human experience. The zone of nonresistance corresponds to **the sacred – to that which does not submit to any rationalization** (Nicolescu, 2002). It is rational but not rationalizable, a distinction often used by Edgar Morin<sup>11</sup> (Morin, 1986).

The unity of levels of Reality and its complementary zone of nonresistance constitute the so-called **TD Object**. As in the case of levels of Reality, the coherence of levels of perception presupposes a **zone of nonresistance to perception**. In this zone there are **no levels of perception**. The unity of levels of perception and this complementary zone of nonresistance constitute the **TD Subject** (Nicolescu, 2002).

Condition for communication between the TD Subject and the TD Object is that the two zones of nonresistance of TD Object and Subject must be identical. A **flow of consciousness** that coherently cuts across different levels of perception must correspond to the **flow of information** passing through different levels of Reality. The two flows are interrelated because they share the same zone of nonresistance (Nicolescu, 2002). Flow of information is in Figure 6 marked with the three oriented loops which cut through the levels of Reality, while the flow of consciousness is marked with the three oriented loops which cut through the levels of perception (Nicolescu, 2002).

The loops of information and consciousness have to meet in at least one point (in Figure 6 the point is marked with X) in order to insure the coherent transmission of information and consciousness. This point is called **Hidden Third**, which is, in some sense, the source of Reality and perception. The point X and its associated loops of consciousness and information describe the Hidden Third of the TK; **the interaction term between the Subject and the Object, which cannot be reduced neither to the Object nor to the Subject** (Nicolescu, 2002).

This ternary partition: {Subject, Object, Interaction}

is radically different from the binary partition: {Subject, Object}

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<sup>11</sup> **Edgar Morin** is a French philosopher and sociologist born Edgar Nahoum in Paris on July 8, 1921. He is of Judeo-Spanish (Sefardi) origin. He is known for the TD of his works (Edgar, 2011).

It is important to note that the three loops of coherence are situated not only in the zone where the levels of Reality are absent, but also **in between the levels of Reality**; the zone of nonresistance penetrates and crosses the levels of Reality. In other words, the TD approach of nature and knowledge offers a **link between the Real and the Reality** (Nicolescu, 2002).

Finally, what appears to be increasingly evident is that we can no longer assume that there is just one reality, fully describable and understandable in terms of pure reason (Max-Neef, 2005).

### 3.2 The Logic of Included Middle

Chapter 3.2 explains how a certain level of Reality can be crossed. Quantum physics leads to understanding of the discontinuing nature of levels of Reality, but the logic of included middle explains **how this discontinuity can be overcome**.

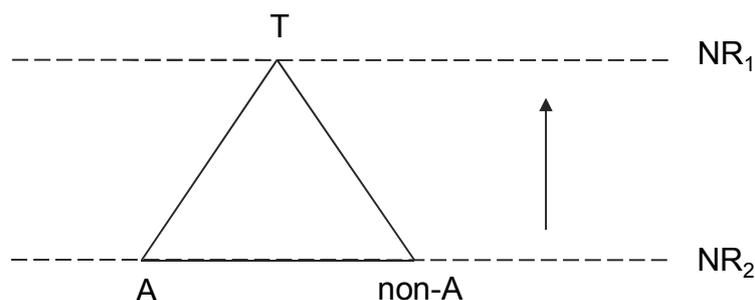
Nicolescu seeks explanation to the problem of knowledge fragmentation that overflows contemporary life. He affirms that **binary logic**, the logic underlying most of our social, economic, and political institutions, is not sufficient to address majority of human problematic situations. It is necessary to rethink everything in terms of what quantum physics has shown us about the nature and logic of the universe. Hence, **the logic of the included middle** can be adequate for solving complex situations, such as those we must confront in the educational, political, social, religious and cultural areas (Nicolescu, 2002).

The evidence about the coexistence of the quantic, i.e., micro, and macro-physical worlds has provoked what were traditionally understood to be mutually exclusive pairs (A and no-A), such as continuity/discontinuity, particle/wave, local causality/global causality, etc. These pairs are contradictory if analyzed through a **classical-linear logic** that recognizes the existence of just one level of Reality. Classical logic of Aristotelian tradition is still predominantly in use nowadays. (Max-Neef, 2005). The classical logic is founded on three axioms (Nicolescu, 2002):

1. The axiom of **identity**: A is A;
2. The axiom of **noncontradiction**: A is not non-A;
3. The axiom of **the excluded middle**: There exists no third term T (“T” from “third”) which is at the same time A and non-A.

By using linear, excluded middle logic the pairs of contradictories are **mutually exclusive**, since one cannot assume the validity of a statement and its opposite at the same time (A and non-A). Already in the 1930th, founders of quantum physics have modified the second axiom of classical logic (the axiom of noncontradiction) by introducing **noncontradiction with several truth values in place of the binary pair** (A and non-A) (Max-Neef, 2005). Stéphane Lupasco has shown that the logic of the included middle is a true logic, formalizable and formalized, multivalent (with three values: A, non-A, and T) and noncontradictory (Stéphane Lupasco, 1987). Two neighbouring levels of Reality in Figure 7 (e.g. NR<sub>0</sub> and NR<sub>1</sub>) are connected by the logic of included middle, a new logic as compared with classical logic.

Figure 7: Symbolic representation of the action of the included middle logic



Source: B. Nicolescu, *Manifesto of Transdisciplinarity*, 2002, p. 156.

The axiom of the included middle logic (Nicolescu, 2002):

**there exists a third term T which is at the same time A and non-A**

Figure 7 presents the three terms of the new logic, i.e.,  $A$ ,  $\text{non-}A$ , and  $T$ ; it presents also the dynamics associated with them. The upper triangle's corner is situated at one level of Reality, other two corners (at the bottom) are located at another level of Reality. The included middle is actually an included third. If one remains at a single level of Reality, all manifestations appear as a struggle between two contradictory elements (corners at the bottom). The third dynamic element (a third term) is exercised at another level of Reality and accomplishes **reconciliation between the two contradictory elements**. The axiom of noncontradiction is thereby respected. **A single level of Reality can only create antagonistic oppositions**. A third term, which is situated at the same level of Reality as  $A$  and  $\text{non-}A$ , cannot accomplish their reconciliation (Nicolescu, 2002).

The logic of the included middle is capable of describing the coherence among levels of Reality by an iterative process in the next stages (Nicolescu, 2002):

1. A pair of contradictories ( $A_0$ ,  $\text{non-}A_0$ ) situated at a  $\text{NR}_0$  level of Reality is unified by a  $T_1$ -state situated at a contiguous  $\text{NR}_1$  level of Reality;
2. In turn, this  $T_1$ -state is linked to a couple of contradictories ( $A_1$ ,  $\text{non-}A_1$ ), situated at its own level;
3. The pair of contradictories ( $A_1$ ,  $\text{non-}A_1$ ) is unified by a  $T_2$ -state situated at a third  $\text{NR}_2$  level of Reality, immediately contiguous to the level  $\text{NR}_1$  (ternary  $A_1$ ,  $\text{non-}A_1$ ,  $T_2$ ).

The iterative process continues to indefinitely (see Figure 6). The open structure of the unity of levels of Reality has considerable consequences for the theory of knowledge because it implies the impossibility of a self-enclosed complete theory. **Knowledge is forever opened**. Such open structure is in accord with one of the most important scientific results of the twentieth century concerning arithmetic, the theorem of Kurt Gödel<sup>12</sup>, which states **that a sufficiently rich system**

<sup>12</sup> **Kurt Gödel** was an Austrian logician, mathematician and philosopher (April 28, 1906 – January 14, 1978). One of the most significant logicians of all time, Gödel made an immense impact upon scientific and philosophical thinking in the 20th century (Kurt Gödel, 2011).

**of axioms inevitably leads to results which are either indecisive or contradictory** (Nicolescu, 2002).

**No level of Reality constitutes a privileged place from which one is able to understand all the other levels of Reality.** This **Principle of Relativity** creates a new perspective on religion, politics, art, education and social life. Consequently, **when our perception of the world changes, the world changes** (Nicolescu, 2002).

The logic of the included middle is a logic of TD and complexity, since it allows, through an iterative process, to cross different areas of knowledge in a coherent manner, and so generating a new integrative knowledge. **It does not exclude the logic of the excluded middle**; it just limits its boundaries and range of influence. Both logics are complementary (Max-Neef, 2005).

**“Contraria sunt complementa”** (angl. *opposites are complements*) was Niels Bohr’s<sup>13</sup> motto. From TD perspective, contradictions, such as day and night, particle and wave, sun and moon, male and female, reason and intuition, matter and spirit, discipline and transdiscipline, are not dichotomies, but complements (see Appendix 6). Hence, contradictory poles converge and merge without losing their identities. In this way A and non-A are at the same time preserved and also abolished. Abolished, because it represents a synthesis, i.e., **a new quality**. According to binary logic, interactions between contradictory elements are in constant tensions and are opposing each other. Systemist Rodriguez Delgado<sup>14</sup> asserts that unity and diversity are not viewed as opposing, but as complementary. Anyway, the principle “*contraria sunt complementa*” is also reflected in the works of the founders of quantum mechanics Werner Heisenberg, Wolfgang Pauli and Niels Bohr.

The methodology of TD is founded on three postulates (Nicolescu, 2002):

1. There are, in Nature and in our knowledge of Nature, **different levels of Reality** and, correspondingly, **different levels of perception**;
2. The passage from one level of Reality to another is insured by the **logic of the included middle**;
3. The structure of the totality of levels of Reality or perception is a complex structure; every level is what it is because all the levels exist at the same time.

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<sup>13</sup> **Niels Henrik David Bohr** (1885–1962) was a Danish physicist who made fundamental contributions to understanding atomic structure and quantum mechanics, for which he received the Nobel Prize in Physics in 1922. “When Niels Bohr was granted a title of nobility by the king of Denmark, as a tribute to his transcendental contributions to science and the culture of his country and of the world, he was asked to make suggestions for the design of his coat of arms. His request was to put on the center the Taoist symbol of the Yin and Yang, and below the sentence: **contraria sunt complementa**. Through that act he revealed the essence of the most transcendental truth.” (Mallmann et al., 1979).

<sup>14</sup> **José Manuel Rodriguez Delgado** (August 8, 1915 – September 15, 2011) was a Spanish professor of physiology at Yale University, famed for his research into mind control through electrical stimulation of regions in the brain (Rodriguez Delgado, 2011).

The first two postulates get their experimental evidence from quantum physics, while the last one has its source not only in quantum physics, but also in a variety of other exact and human sciences (Nicolescu, 2002).

Levels of Reality are, in fact, **projections** of the Subject from a certain level of perception. This is why **Reality cannot be reduced to a substance** (matter). TD Object could figuratively represent exact (positive or “value free”) science and TD Subject could represent inexact (normative) science. From this point of view the TD logic introduces the methodology for collaboration of exact and inexact sciences (Hidden Third), by following a common goal. Because of the principle of non-contradiction, **TD approach is not hierarchical** (there is no fundamental level), thus no discipline could dominate over other. The TD concept provides reconciliation between reductionism, i.e., existence of only one level of Reality, and non-reductionism (infinite levels of Reality). This approach is much applicable in the context of SD where, e.g., ecology and economy are in tense relationship which is the result of binary thinking based on excluded middle logic.

**Hidden Third transforms knowledge into understanding.** The latter, in this context means a fusion of knowledge with the being. TD is the unified theory of levels of Reality valid in all fields of knowledge (there are more than 8000 academic disciplines). We could imagine how many levels of Reality constitute today much fragmented **8000 disciplines**. There is no opposition between disciplinarity and TD, since TD is not in-disciplinarity (it is not a discipline, but a concept). However, TD is a promising starting point for filling the gaps between many fragments of knowledge and human being.

Open structure of levels of Reality has big epistemological consequences, since it implies the impossibility of constructing a complete theory and assumes a permanent potentiality for the evolution of knowledge. From these considerations, it may be proposed that: “**Every theory at a given level of Reality is a transitory theory**, since it inevitably leads to the discovery of new contradictions situated in new levels of Reality”. Such a process can continue indefinitely (Max-Neef, 2005). Even though ideas of TD logics (Logic of included middle) are relatively old, such logical efforts still remain controversial for contemporary mainstream society.

### 3.3 Complexity

We are witnessing the appearance of complexity, of chaos, and of non-linear<sup>15</sup> processes in many areas of science. Systemic visions have brought about the abandonment of the traditional linear logic assumptions that nature can be described, analyzed and controlled in simple terms. All these new concepts have revolutionized many areas of science. However, **no significant breakthrough** can be found in disciplines related to **social action, economics and politics**. Paradoxically, the concept of a simple, linear uni-dimensional Reality seems as strongly

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<sup>15</sup> In mathematics, a **non-linear system** is a system whose output is not directly proportional to its input. Nonlinear equations are difficult to solve and give rise to interesting phenomena such as chaos. The weather is famously chaotic, where simple changes in one part of the system produce complex effects throughout (Nonlinear system, 2011).

grounded as ever, precisely at a time when we are trying to adapt ourselves to a world undergoing structural change. Such an incoherence is largely responsible for many of the crises affecting us today (Max-Neef, 2005).

Nowadays, we have reached a point in human evolution in which we know very much, but understand very little. Thanks to linear logic and reductionism the knowing has grown exponentially, but only now we begin to doubt that this may not be sufficient, not for quantitative, but for qualitative reasons (SD). Knowledge is only one side of the road; the other side is that of understanding (Max-Neef, 2005).

Finally, Max-Neef in his paper titled “Foundations of TD” (2005) provides interesting remarks: “While within the realm of knowledge it makes sense that I (Subject) pose a problem and look for its solution (Object) [...] in the realm of understanding no problems exist, but just transformations that permanently integrate Subject and Object. We may, therefore, perhaps conclude that **knowing and understanding belong to different levels of Reality**. It is clear that formal knowledge, linked to reason, is constructed following rules of method and causality, while understanding, more linked to intuition, rules out both method and causality. Hence, being in different levels of Reality, understanding may solve the contradictions that arise in knowledge” (Max-Neef, 2005).

From all of that what have been expressed so far, it should be clear that TD is an unfinished “project”, around which there is still much to be discovered and investigated.

### **3.4 A Critical View of Foundation of the Concept of TD**

In the theoretical part of the master thesis the definition of the concept of TD moves from the “exclusion of values” to the “inclusion of values”. In the literature, related to TD foundation, there was nowhere clearly expressed what kind of values were meant to be excluded or included. By the basic research, which integrates the concept of human value in the concept of TD, the ambiguity is somehow solved.

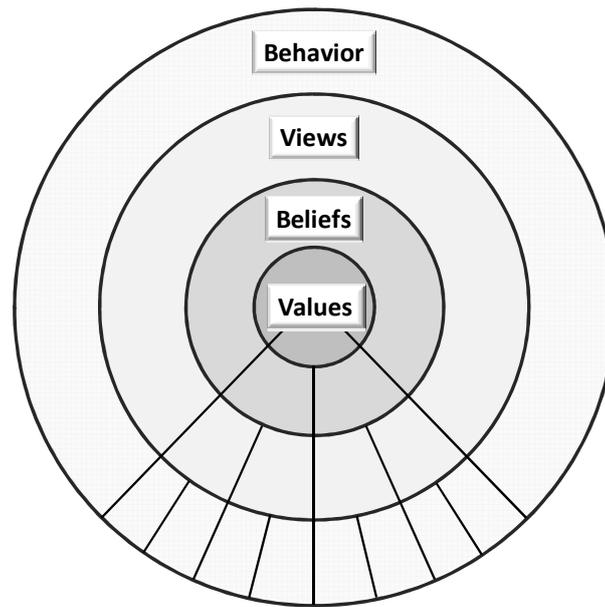
#### **3.4.1 Values Clarification**

A number of definitions and conceptions of values can be found in the literature. Here there are mentioned three more or less broadly accepted definitions. Clyde Kluckhohn (1951) defines values as concepts of the desirable, which influence how people decide on actions and how they evaluate events (Musek, 1993b). Another English definition (Musek, 1993c) is that “the values are abstract, often implicit conceptions, which define to the individual the goals or means for attaining the goals he considers as desirable”. **Musek**<sup>16</sup> (1986) defines: “**Values could be understood as motives or motivational goals on a very high level of generality**. They could be conceived as general and relatively consistent ideations of goals and events, which we highly estimate. [...] One can view them as the most general motivational goals”.

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<sup>16</sup> **Janek Musek** (June 3, 1945) – Professor of general psychology at Faculty of arts (Department of psychology), University of Ljubljana.

Figure 8: Values as a source of beliefs, views, and human behavior

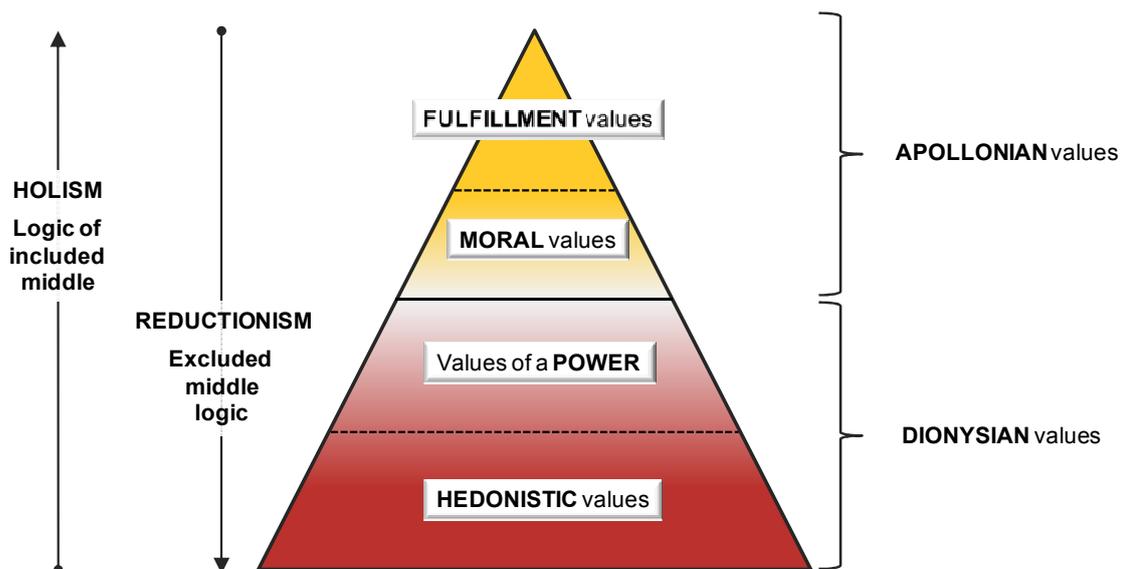


Source: J. Musek, *The new psychological theory of values*, 2000.

All three definitions of values share a common opinion that values are a prior origin for beliefs, views and eventually for behavior and human action (see Figure 8).

The answer to the ambiguity expressed at the beginning of this chapter can be found in publications of Janek Musek. He has classified values into a number of categories, occupying different levels in the hierarchical structure of human goals (Musek, 1994).

Figure 9: The four-level hierarchy of values



According to Musek’s hierarchical structure of values there are only two very large categories (macrocategories) of values, i.e., **Dionysian and Apollonian macrocategories** (see Table 2). Both levels further splits into additional two levels or subcategories, which could be called value types. Dionysian values consist of two types of groups, namely hedonistic values and values of a power. **Hedonistic values** contain values related to sensual and material pleasures, while **values of a power** involve values related to achievement, success, reputation, and also patriotism. Further, at the next level, each of the value types could be again divided into another values category. Hedonistic type separates into sensual, health and safety categories, the values of power into social status and patriotism categories. Finally, at the most specific level of the hierarchy there are various single values, which can be derived from the middle-range categories of values (Musek, 1994).

Table 2: J. Musek’s scheme of value

Macrocategories	DIONYSIAN values		APOLLONIAN values	
Type of values	HEDONISTIC values	VALUES of a power	MORAL values	FULFILMENT values
Values in the middle range category	sensuality health safety	social position patriotism legislation	traditionalism family societal values	culture aesthetics actualization cognition
Specific values	entertainment comfort sexuality security enjoyment ...	reputation money success native country laws ...	honesty goodness love (peace) partner equality ...	creativity beauty self-realization knowledge wisdom ...

Source: J. Musek, *The new psychological theory of values*, 2000.

Apollonian values are similarly divided into two value types. The first group – **Moral values** consists of traditional and societal values. The second group – **Fulfillment values** gather values related to personal, cultural, and spiritual growth. Again at the next level, each of the value types could be further divided into the middle-range categories of values. The moral type consists of traditional, democratic (or societal) and social values, while the Fulfillment values involve the cognitive, cultural, self-actualizing and spiritual values. At the specific level of hierarchy, the moral type consists of values such as honesty, love, equity, etc., while fulfillment values include values such as creativeness, knowledge, beauty, self-realization and so on (Musek, 1993a).

To return to the beginning of this chapter, the uncertainty about the dilemma of which values are considered in the concept of TD, it can be argued that these are values related predominantly to Apollonian values. But, due to the TD principle of non-contradiction, **values related to Dionysian group are not being excluded. The latter values can be attributed to the TD Object, but Apollonian values can be assigned to the TD Subject.**

**Apollonian values correspond to the holistic approaches, whereas Dionysian values correspond to the reductionistic attitudes.** Only when a human perception is holistic the morality and ethics could be considered. An individual with Apollonian values is centered on a community as a whole and not only on himself/herself, as in a case of Dionysian values.

All the values (no value reductionism) together may be favorable to SD, but only in a balanced context. When for example Apollonian values predominate over Dionysian values, consequently the TD Object is put aside and vice versa. Another example is when Dionysian values prevail over Apollonian values; in this case another unsustainable condition is established where consequently significant contradictions or even conflicts (see also Appendix 6) are not excluded. Such a situation is present in today's socio-economic system where Apollonian values are neglected and seem to be ridiculous. But consequently such ignorance contributes to majority of global crisis.

Capitalism replaces Apollonian values (TD Subject) with Dionysian values (TD Object) or even equalizes them, but can Apollonian values be bought? The human values of capitalism are only consumables, and that we can produce new, we must destroy the old ones (Žižek, 2009).

One can express concerns about how to change human values which would eventually modify his/her behavior towards sustainable consequences. **Changing values is related to changing levels of perception;** but not to changing values itself. Therefore, **the values are what they are and they cannot be changed** (they can be only gained), they are invariant, similarly as it is explained in the case of levels of perception (see Chapter 3.1). They can be only understood as a consequence of different states of consciousness. **Human can only change behavior by encouraging altered states of consciousness and accordingly accept different types of values.** In relation to the concept of TD, the change in level of perception results in the change of fundamental concepts (like, for example, causality) and eventually results in change of level of Reality.

#### **4 TD IN THE SD CONTEXT**

Chapter 4 includes the second part of the basic research (first part is located in Chapter 3.4). It provides my contributions to a holistic understanding of SD and also an alternative to the mainstream “green reformism”. By using intuition, creativity, and imagination, I integrate SD with the concept of TD.

A unified theory of levels of Reality is crucial in building a sustainable future. The present consideration of SD in the literature and media is basically reductionistic and implies mostly binary thinking, e.g., they promote settlement of technology and faster growth of a “**green**” **GDP**, but not saving nature and human being itself. In this linear, standard view everything is reduced either to society, economy or environment. **The meaning of a self destructive human behavior as well as Apollonian values are completely ignored.** Reductionism, binary logic and disciplinarity (mono-, multi- and interdisciplinarity) approach are misplaced beliefs.

Figure 10: Ontological correlations between the concepts of TD and SD

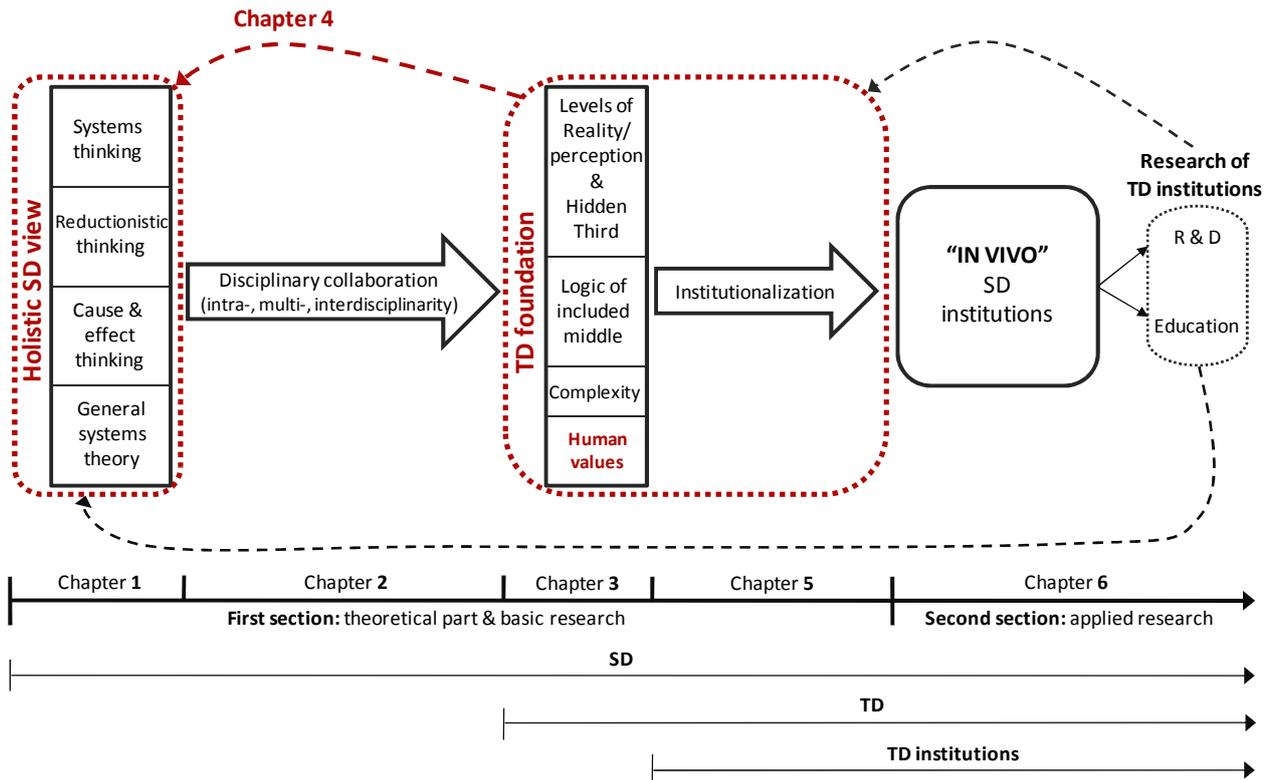


Figure 10 shows the mind map of this section of the master thesis (follow the red lines). The purpose of Chapter 4 is to find connections between TD foundational ideas (see Chapter 3) and holistic SD view (see Chapter 1). These connections represent the starting point for the last (applied research) section of the master thesis, where “IN VIVO” institutions are placed in the forefront. However, the structure is designed to follow the content.

It is expected that the concepts of TD and SD not only match, moreover they are also complementary. Complexity, systems thinking, levels of Reality/perception and solving strained contradictions are already at first glance the common areas.

#### 4.1 Integrating TD with SD

In the available literature I have not been able to find comprehensive explanation of ontological correlations between the concepts of TD and SD. For this reason, I address in this chapter more or less my own understandings (with some help of selected authors) about relations between the two concepts and of how TD could be applied to SD.

Nevertheless, the most comprehensive contribution to this challenge can be attributed to relatively new scientific field of **ecological economics**. It implies TD to address the complexity and uncertainties of the co-evolution of the natural and the social system (Norgaard, 1994). Due to field of specialization ecological economics is relatively close to **environmental economics**. But ecological economics focuses on economy as a social system imbedded in its environmental

surroundings, whereas environmental economics focuses on the environment as a subsystem of the economy (Polimeni, 2004).

Ecological economics is an academic field of study that merges ecology with standard economics. Ecological economics is a prominent example of a “**green reformism**” (see Glossary), which represents a mainstream response to the current ecological crisis. The term refers to the support for improved technology and resource efficiency combined with a commitment to the logic of capitalism (Rotering, 2011). Frank Rotering believes that ecological economics is founded on paradoxical basis, because it simultaneously adopts capitalism (as a mean for solving problems of unsustainable development) and at the same time rejects economic growth. It is committed to capitalism, uses standard concepts and believes that the same system can achieve long run stability. Although the field has developed comprehensive way of natural resource management, it has quite deficiently defined human well-being.

Sustainable world needs to build **responsible, desirable vision, but this requires imagination** that comes not only from logic, but from values (Meadows, 1996, p. 117). The rational process of figuring out how to achieve a sustainable world must begin with a nonrational act of imagination (Prugh, Costanza & Daly, 2000, p. 41). **Problems of unsustainable world are interrelated** and have origins in different polycrisis (there is no one, single big problem – only a series of overlapping, interconnected problems). Consequently, it is impossible to imagine only one solution, but rather **many complex interrelated solutions**.

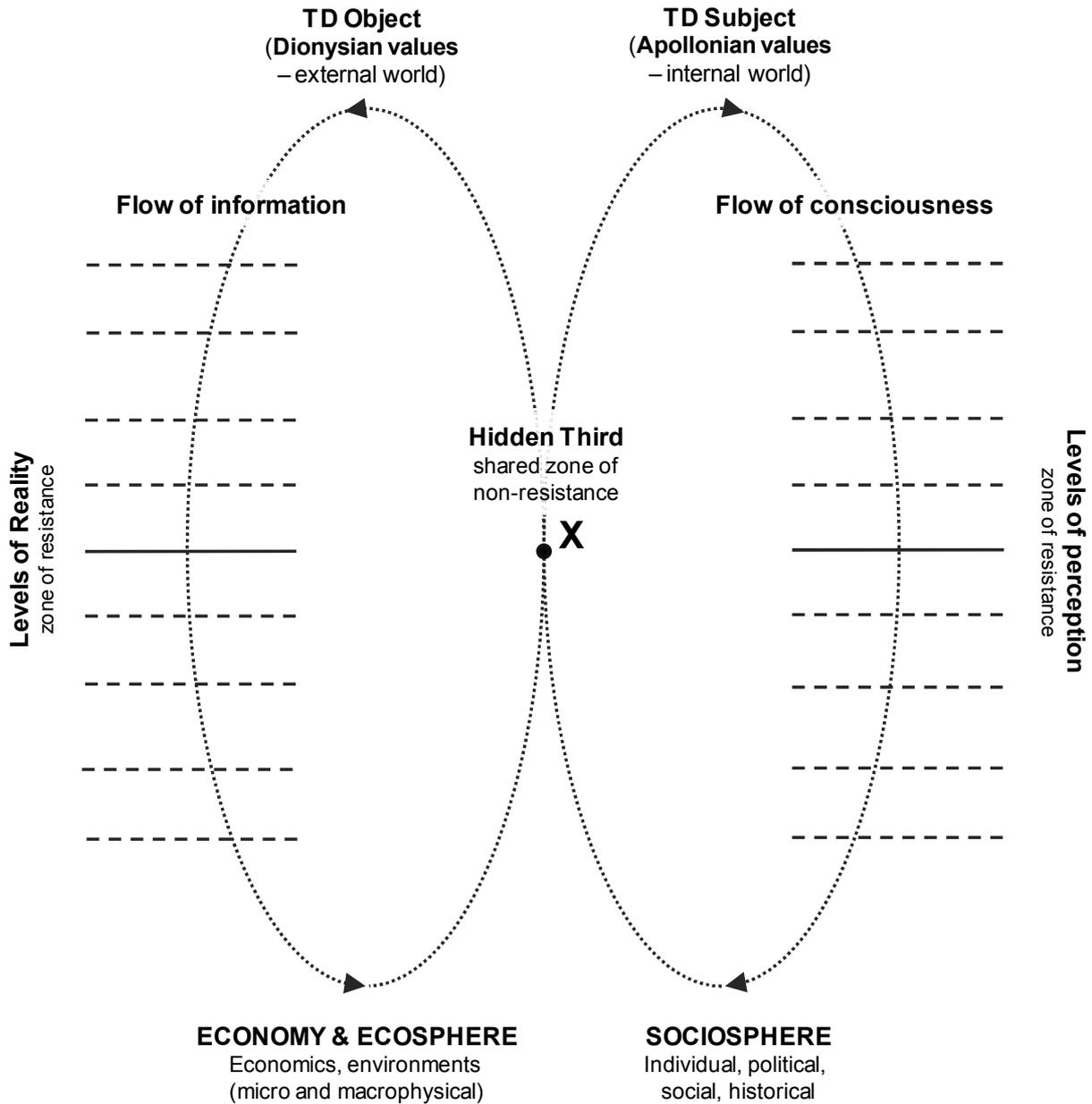
#### **4.1.1 The TD Object, the TD Subject and the Hidden Third**

In general there are three TD terms: Object, Subject and the Hidden Third. These three terms are non-separable. TD studies how interactions of Object and Subject create new TK. Hidden Third represents connection between external/internal world and also between information and consciousness flow. Figure 11 shows how the three TD terms, and also levels of Reality and information/consciousness flow can be applied to SD.

**TD Object** represents external world which in SD terms could imply areas of **ecosphere** (environments) **and economy** i.e., physics, biology, economics, chemistry, etc. It is composed by physical elements in the environment without paying attention to relations between them, thus the meaning of the elements is excluded (it considers only the content of the elements). Dionysian values are focusing on this physical world.

**TD Subject** gives the meaning to the elements of the TD Object, i.e., the meaning from individual, political, social, historical point of view. It symbolizes human relations and relationships towards TD Object. In terms of SD, we can understand TD Subject as **sociosphere** comprising philosophy, psychology, anthropology, humanistic, etc. The role of SD is to provide new meaning to TD Object and to human activities. The human internal world, where consciousness flows, is a source of tolerance, justice and other Apollonian values.

Figure 11: Ontological interconnectedness of TD and SD



Source: Adapted from B. Nicolescu, *Manifesto of Transdisciplinarity*, 2002, p. 155.

**Knowing is not the same as understanding.** You can only understand that of which you become a part, when the TD Subject that searches and observes becomes **integrated with the TD Object**. Most attempts to unify TD and SD have failed because of exclusion of the role of the TD Subject (also in the case of ecological economics). Individual and spiritual level of Reality and also the meaning of Apollonian values were here mostly ignored. For example, could we affirm that economic growth and environment (A and non-A) are opposites only at the biocentric level? Could such opposition be solved from the biocentric level of an ecological economics through which growth and environment (as complementary opposites) become a unified field (Max-Neef, 2005)? It is most likely impossible, since ecological economics does

not take into account anthropocentric view (TD Subject) and the means of market economy (neoliberal capitalism).

**Hidden Third** plays a role of a mediating mechanism that links the TD Subject with the TD Object and makes it possible to unify knowledge necessary for developing holistic sustainable future. People's experiences, interpretations, descriptions, representations, images, and mathematical formulations meet there in the form of TD Reality (Nicolescu, 2002). In addition, **Apollonian and Dionysian values meet here** in the zone of non-resistance which enables people to grow in terms of Apollonian values, that is, to reach new levels of perception/Reality. **Essentially, the ethical dimension is a core of SD and without it SD is like fiction.** Ethics, related to SD, encompasses at least three aspects: the moral relationship between humans and other currently living humans, future generations of humans, and non-human nature. There are not many people who deal with ethics (as philosophical discipline) in our society, because such a profile is unemployable. In current society, there are no such positions of employment, since the ethical dimension is not in the interests of neoliberal capitalism. Therefore, **in our society, SD is like fiction.**

Moreover, Max-Neef (2005) argues that the inclusion of **Apollonian values distorts the efficiency of the market.** Thus, it should not be surprising that efforts to overcome poverty tend to fail systematically. It is obvious that if Apollonian values, oriented towards the common good, are not made explicit, no policies coherent with the SD challenge can successfully be designed. For instance, the so called poverty eradication policies are, in the fact, not policies. They are rather mechanisms to stimulate economic activity, under the assumption that sole activation will point to the solution of the bigger problem. If equity and the components of the common good were actually specified, the assumed role of the market would be limited to that for which it is really useful and efficient, and not for the overcoming of poverty. As Adam Smith's **invisible hand** is nowadays becoming more visible, not as only orientator of economic activity, but also as (in)visible human greed.

However, in the shared **zone of non-resistance**, people share their resistance to truth and join realities to generate comprehensive TK. Without the Hidden Third, it would not be able to integrate perspectives from different realities, e.g., economics with ecology. It would not be possible to integrate the Subject with the Object. It seems, that current mainstream **“green reformism” is focused more or less on solutions related to the Object** (technology and natural resource management) while ignoring the Subject and consequently moving away from the Hidden Third, which is, in fact, source of SD (see Figure 11). In the broader sense, Hidden Third enables the methodology for holistic and integrative SD conceptualization and implementation.

Classical physics assumes continuity, which means that, things cannot move from one point of space and of time without passing through all intermediary points. With other words, nothing can be skipped over; everything has to be continuous, with no interruptions. On the other hand, quantum physics assumes that moving from one territory to another does not require the boundaries to be actually touched. **The mediate role of Hidden Third makes it possible to create TK without being burdened by the disciplinary boundaries.** Definitely, there must be a

place for disciplinary and interdisciplinary activities (based on continuity), while creating TK (based on discontinuity).

Nicolescu (2002) acknowledges that humans have always accepted existence of at least two realms of Reality – one visible and the other invisible. The Hidden Third is the invisible realm in TD ontology. The Hidden Third is mediator of the flow of information with the simultaneous flow of consciousness in a way that different minds can link and share information and perspectives. Without inclusion of the Subject it is impossible to imagine unity of DK, since **without Subject there is no flow of consciousness**. In environment, where the TD Subject is able to communicate with the TD Object, there is much bigger chance for a new knowledge breakthrough and for finding intelligent and intuitive solutions to complex SD problems.

When people overcome their resistance to differences or contradictions, it consequently lets them to cross levels of Reality and to realize other perspectives. **The Hidden Third inherently lets people go of aspects of how they currently know the world**; it is a place where people become open to other perspectives, ideologies, values and belief systems. Cole (2006, p. 13) understands Hidden Third as transition zone which “involves a breakdown in the laws and logics that hold in the person’s perception of Reality”.

There is no need to find what is “Real”, that what is valid forever, i.e., ultimate truth, since it is also hidden forever. Anyway, the unity of different levels of Reality can bring us closer to a holistic sustainable wellbeing, without passing through overwhelming devastating conflicts (see Appendix 6), but by passing through the Hidden Third. SD can be based on open and unified theory of levels of Reality. **In current era, one can notice predominance of misplaced beliefs such as reductionism, binary logic and disciplinarity. TD does not oppose them; it rather gives them a new meaning.**

#### 4.1.2 Levels of Reality/Perception and the Logic of Included Middle

Nicolescu (2002) defines “level of Reality” as a group of systems which are invariant under certain laws. Two levels of Reality are different if there is a break in the laws and a break in fundamental concepts (like, for example, causality). At the same time there exists discontinuity between levels of Reality. Every level associates space and time, while each level of Reality sustains every other level of Reality. He also asserts that, **one level cannot be understood in the terms of the laws and concepts of another level**. The structure of the totality of levels of Reality and perception is a complex structure. Nevertheless, in order to understand the complex structure of TD Reality, people have to accept that levels of Reality are not only separated, **they are also connected with the logic of included middle** (van Breda, 2008).

Taking into account all these statements, it can be argued that **scientific disciplines with different laws and fundamental concepts are located on different levels of Realities**. On a certain level, there could be grouped two or more disciplines sharing joint laws and concepts. For example, we can also find common levels of disciplines by exploring their organization, language, interpretation, complexity, knowledge, integration, being, etc.

**Most of the disciplines (also economics) consider only one level of Reality** (Nicolscu, 2002). Due to classical (linear) logic, **they accept a certain Reality as being ultimate truth**. But the passage from one level of Reality (group of disciplines) to another is insured by **the logic of included middle**. Accordingly, to use knowledge from different levels of Reality, one has to give a new meaning to a DK in accordance with the common aim of a certain project.

TD ontology presumes that every level of TD Reality is characterized by incompleteness because the laws governing one level are just a part of the totality of laws governing all levels. At the same time there is no one fundamental level of Reality (Nicolescu 2005). Therefore, there exist no hierarchy between the disciplines and no discipline could be superior over other disciplines. SD policy should not exclude, but rather include different spectrum of academic disciplines from economy, sociosphere and ecosphere. **The balanced prominence of these areas can ensure a balanced development.**

**Every discipline, by itself, has its own content, but no meaning. A discipline gets its meaning only by establishing relations and relationships with other disciplines.** As Boulding points out: **“Somewhere between the specific (discipline) that has no meaning and the general (all disciplines as one discipline) that has no content there must be an optimum degree of generality”** (Boulding, 1956). It is context (problem, goal) dependent which and how many disciplines are included or excluded in preparation or implementation of a certain project.

Taking into account the logic of included middle, the **reconciliation between two or more contradictory disciplines creates a new temporary T state** (see Figure 7), which represents the **emergence of new non-disciplinary insights and perceptions** (TK). The logic of included middle does **not provide final T state** according to the assumption of ever opened knowledge; there exist only **temporary reconciliation** of any contradictions or antagonisms between A and non-A (Cole, 2006). The process of reconciliation is consequently never ending. **TK has no final truth; it is rather evolving and always unifying DK. Reality depends on us**, it is plastic (it is created and not given) and our responsibility is to build sustainable future in accordance with Apollonian values. Because Reality is dynamic, it is impossible to arrive at an exact and complete point of Reality. “Reality depends on us” because “we are part of the movement of Reality” (Nicolescu, 2010).

However, once we understand and accept the theory of different levels of Reality and its associated logic of the included middle, both the **vision and the way in which to proceed become clearer**. The first principle is **not to separate the opposing poles** from the many bi-polar relations that characterize the behavior of nature and of social life. Such a separation is normal for rational thinking and its correspondent linear logic. **Separation of bi-polar relations is, in fact, artificial**, i.e., illusionistic, since **neither nature nor the human society does function in terms of mono-polar relations**. Insistence in artificially simplifying our knowledge about nature and human relations is the force behind the increasing disfunctions of relations and relationships of eco-systems and its social and economic subsystems (Max-Neef, 2005). The results of such rational thinking are even bigger tensions between oppositions, i.e., wars, non-

participation and violent exclusion, world crisis, unhealthiness, isolation, loss of the meaning of living, etc.

Certainly, the logic of classical physics is quite appropriate for simple problems, but is harmful when applied to the solution of complex problems (e.g., climate change, global justice, sustainability, poverty, etc.) (Nicolescu, 2005). The polycrises facing humanity today cannot be adequately solved by using DK. **Discontinuity between the levels of Reality could be overcome when the flow of consciousness and information enable “uncovering” new levels of Reality and thus reaching new knowledge.** Such phenomena cross disciplinary boundaries in order to create holistic SD solutions. By unifying various disciplinary knowledge TD approach does not create new discipline, but rather new knowledge or solution which is at once between the disciplines, across the different disciplines and beyond all disciplines.

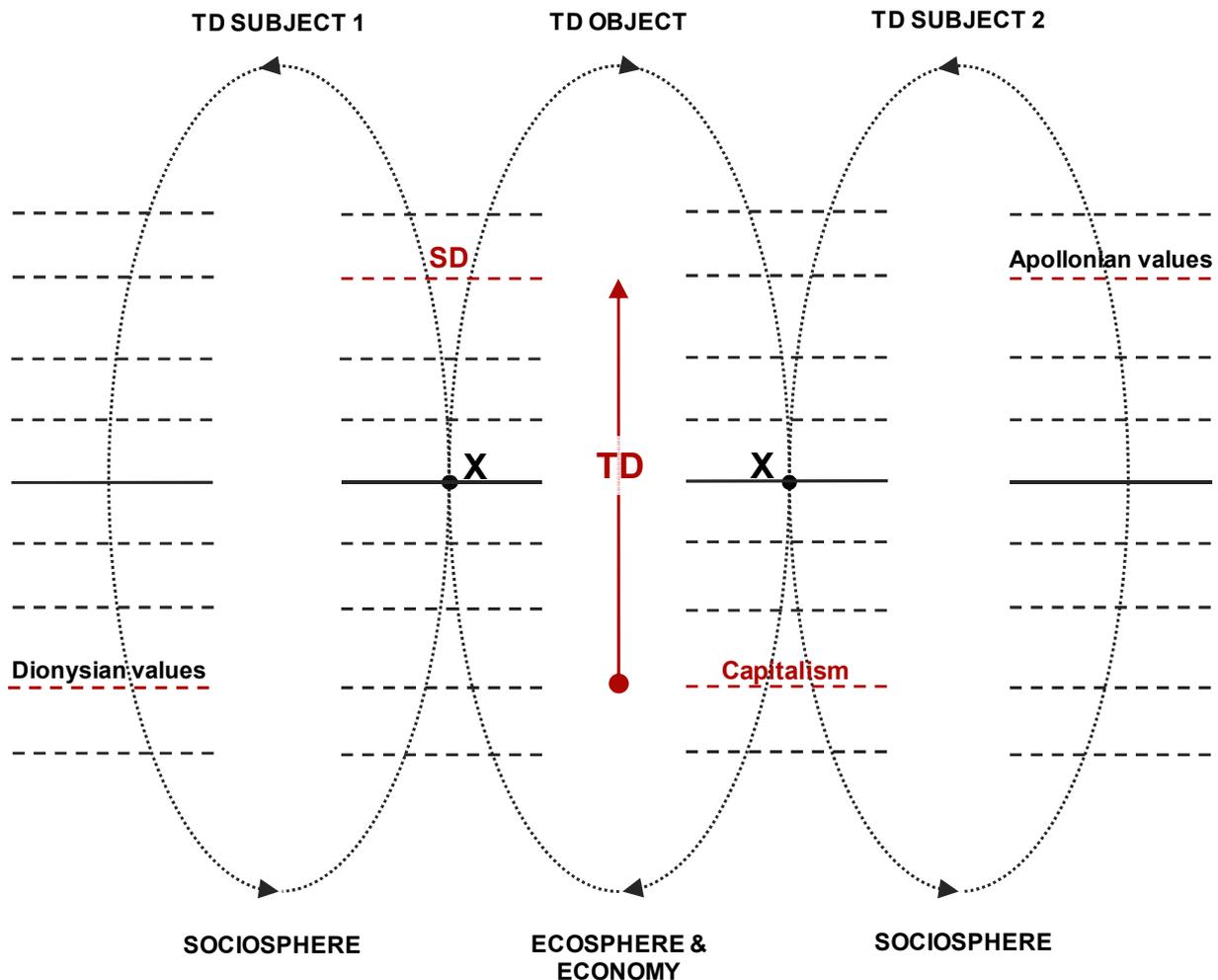
#### **4.1.3 Communication between the TD Object and the TD Subject**

Communication between the TD Object and the TD Subject is possible, when the **flow of consciousness and the flow of information** are introduced in the concept of TD. **Dialog or communication between disciplines is not self-evident, as in the case of dialog between religions and cultures.** Humans often experience resistance to ideas coming from other disciplines and perspectives, probably because they are not aware of discontinuity of their discipline (culture or religion). To resist means to “oppose” and/or to experience unwillingness or unresponsiveness to changes. In order to gain new insights into complex sustainable problems, people need new insights and perceptions; it can only be perceived from new, more holistic viewpoints. This is possible if people are able to move their points of reference back and forth between different realities, e.g., between academics and social actors (Cole, 2006). In order to pursue holistic SD a new viewpoint is needed, since current “**green reformism**” attempts to solve polycrises from the same level of Reality as the problems were created. **An awareness of discontinuity of this level is required.**

**The flows of consciousness and the flow of information are the most dynamic components in the concept of TD;** furthermore, the flows might put the TD Subject and TD Object in dynamic processes of **self development/growth in terms of Apollonian values** (see Figure 12).

For example, in relation between ecology and economy there is a break in the laws and a break in fundamental concepts; this means that they belong to different levels of Reality. Nowadays, they are in a tense relationship which is the result of binary thinking based on excluded middle logic. **SD needs to release this tension and develop a common unifying concept on the same level of Reality.** To accomplish that, there is a long way of solving contradictions and finding common meaning with different content. Nevertheless, this could be achieved only through changing of levels of perception of people (see Figure 12) in both disciplines in order to pursue a common goal. **Two disciplines cannot have the same content, but they can share the same meaning.** TD approach integrates different disciplinary contents under a common meaning within a specific common goal (to create TK).

Figure 12: Two TD Subjects sharing the same TD Object on a different level of Reality

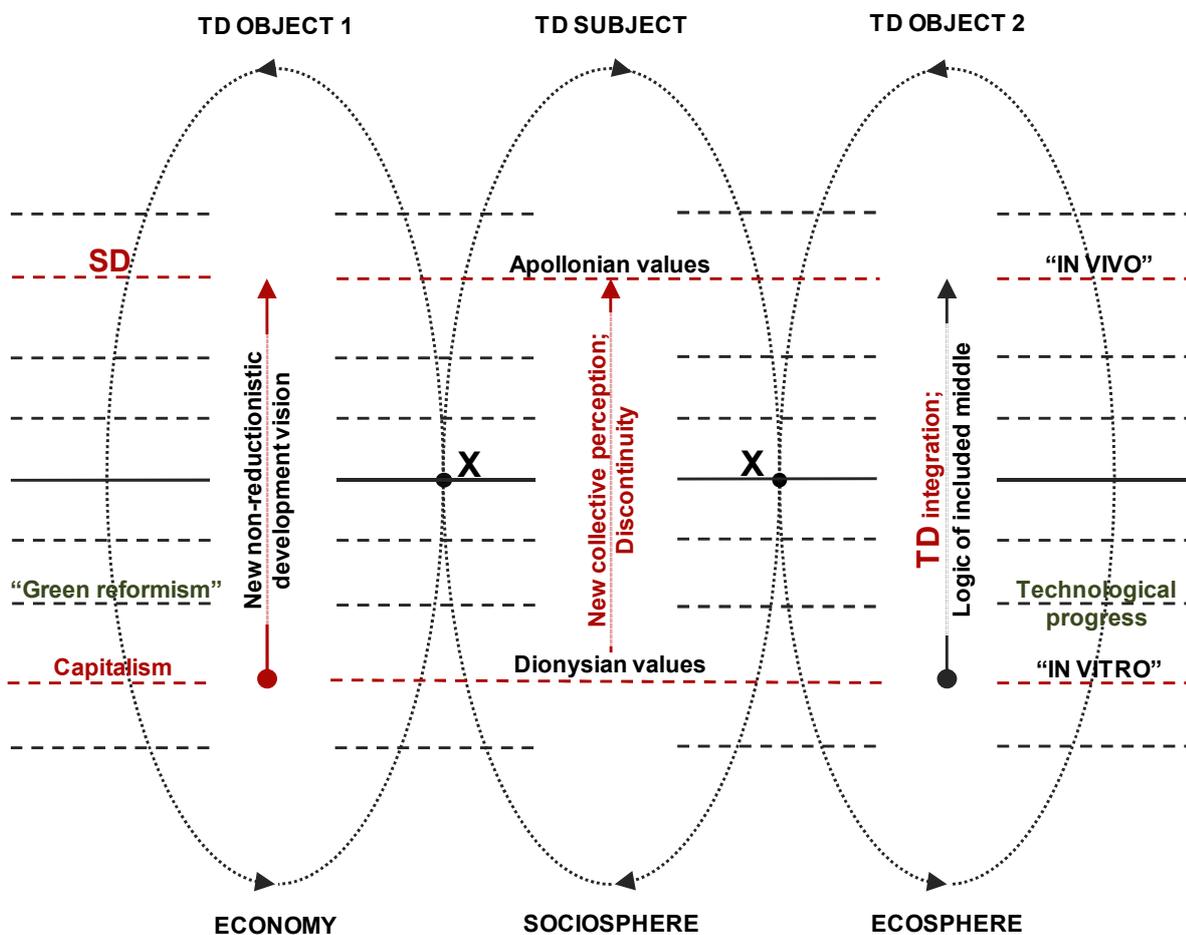


However, the fundamental SD question is “how to change levels of perception of people being employed in disciplines with contradictory concepts to pursue a common goal”? The answer of the TD approach is: **by the flow of consciousness/information and by the “operating” shared zone of non-resistance**. After all, is society ready for such a visionary transformation? Sooner or later it has to be.

**The “green reformism” acts like that we still have plenty of time** for negotiations, making changes, developing strategies, etc. Therefore, it would be better for the mankind to behave as all was already destroyed (awareness of discontinuity of destruction). When dealing with ecology, we should be aware of **discontinuity of present human behavior**. It is most likely that radical changes are needed. All of us have prejudices, our representations (horizons), but to overcome these limitations we have to cross different levels of Reality by the logic of included middle. **The unconscious barrier** to a TD dialogue comes from the inability of a human to think about discontinuity of a certain level of Reality (McGregor, 2011). To realize another level of Reality one has to give up an attachment to existent level of Reality and “prepare space” for new Reality.

Particularly economists must be able to communicate with the natural sciences (see Figure 13), social and human sciences, if we are to solve the complex problems. Economy and sociosphere should be perceived from the common level of perception. **TD means to reach out beyond science and also to include aspects of empirical/practical contexts.** Combination of disciplinary and civil society knowledge is required. TD ontology encourages people to seek **multiple perspectives** on any set of human problems; this process involves considerations of chaos, resistance, contradictions, antagonism, reconciliation, logic of included middle, etc. (Nicolescu, 2002). Figure 13 represents a synthesis of what has been said so far in the first section of the master thesis; it illustrates the concept that could be a “counterbalance” to the circular flow model that forms the centerpiece of the mainstream economic view of the SD.

Figure 13: TD Subject perceiving two TD Objects on different levels of Reality



Here is an example of TD approach that has been used for the regional development project in Austria “**Leben 2014** (Life 2014) – perspectives for integrated regional development in the national park of Oberpinzgau region, Salzburg”. “Leben 2014” was an integrated teaching and research project. The main findings of the project indicate that a key for successful TD cooperation is **the integration of also non-academic actors** at an early stage of the project, i.e., at goal setting. They came to conclusion that the implementation of a **structure of communication and the definition of rules of collaboration** play a significant role (Muhar et al., 2006).

Accordingly, people in charge of TD projects must be able to interact with local community leaders, colleagues, partners and stakeholders from diverse backgrounds, as well as coordinate participatory planning processes to implement SD goals. Effective practitioners should have skills of “**social entrepreneurship**” so that they can pull together a variety of political, financial and institutional resources to develop common new ideas. (Muhar et al., 2006). Such projects demand cutting across the institutional borders of academia, civil society, and government.

In order to develop analyses and solutions for practical complex problems, science needs **factual and tacit knowledge** about the systems and problems it studies. **Communication with societal actors** can help to identify relevant research questions of a problem under study. Furthermore, it can also facilitate the adoption and implementation of solutions (Baumgärtner et al., 2008, p. 387). We have to consider interconnectedness between the academy and civil society, otherwise we cannot solve the problems facing humanity.

If we assume that non-reductionistic approach leads to defragmentation of knowledge and that holistic knowledge is the most appropriate tool for complex problem solving, than there is **no need to create new discipline**, but rather understand the present world form several perspectives. Due to TD logic no part can be self-sufficient by itself; all of the parts are interrelated and share a common meaning. The only sustainable system is the holistic system in all of its dimensions and particles.

## 4.2 The TD Solutions at Different Levels of Social Integration

TD approach can be implied at different levels of social integration. It offers solutions to the individual, organizational-institutional, regional, and national-global level. The starting point (the source of change), **initially occurs** at the individual level with the ability to change a level of perception and consequently changing a level of Reality. At the individual level, each individual is left to itself and to his/her personal beliefs to the extent that they are not forced upon him/her from the environment.

- 
1. **Individual level:** changing (discontinuity) levels of perception and consequently changing (developing) projections to new levels of Reality (see **Figure 11**); it solves the crisis of human perception, lack of vision and imagination in the SD context.
  2. **Organizational-institutional level (micro sphere):** TD integration of disciplines and knowledge (especially when they are in conflicts) (see **Figure 12**); result is a new TK and the vision.
  3. **Regional level:** integration of different stakeholders (non-academic actors and civil society) at early stage of a project, i.e., at goal setting (see **Figure 13**); result is clarification of the regional development vision and solved real world SD problems.
  4. **National-global level (macro sphere):** opening up opportunities for a change in the socio-political and economic system (see **Figure 13**); solutions are emerging visionary SD systems.

The applied research, in the second section of the master thesis, involves subjects from the organizational and institutional level, i.e., educational and research organizations. Other levels of social integration are not included in the applied research. From the analysis I have found that the solutions of the TD approach are the most common in the second – organizational institutional level. Frequent use of the concept of TD can be also noticed at the regional level (regional TD development projects), while at the national-global level it is widely accepted by the UN especially in the DESD context. However, the use of the concept of TD at the broadest level is still in the initial emerging phase.

## 5 INSTITUTIONALIZATION OF THE CONCEPT OF TD

Since the late 1980s, multiple disciplines have been involved in cross-disciplinary research programs in several western countries, e.g. Spain, Canada, and Denmark, as well as in the US ecosystems assessments (Haugaard Jakobsen, Hels & William, 2004).

How to facilitate the reconciliation of fragmented disciplines, divergent opinions and policy processes that constitute the contemporary sustainability debate? In general, people are facilitated away from the need to participate in the evolution of more generally shared insights. Nevertheless, much can be gained through facilitating the reconciliation by developing a **“learning environment”** for discussions. Lessons from systems thinking and the science of complexity are suggestive of some potential in this context (Meppem & Gill, 1998).

Despite TD concept does not assume creating new disciplinary environments, in the literature there can be found some emerging TD disciplines. Probably the most developed TD perspective on economic complexity is **econophysics**. It was developed in the mid-1990s by H. Eugene Stanley as the “field that denotes the activities of physicists who are working on economic problems to test a variety of new conceptual approaches deriving from the physical sciences” (Barkley Rosser Jr., 2010). Further, **ecological economics** may constitute a self-conscious TD initiative; the same cannot be said for nascent **econobiology** developed by econophysicists (McCauley, 2004). Some evolutionary economics are oriented to the biological roots, and some imply or emphasize complex dynamics. A well-established **mathematical bioeconomics** has been more readily opened to models of complex dynamics and looks to be the most serious foundation for a potential econobiology that would be able to interact with econophysics. A **grand synthetic TD perspective on economic complexity** is probably beyond our reach, but the TD perspective at a more modest level is alive (Barkley Rosser Jr., 2010).

Although SD is an inherently TD issue, there is much to be gained from **examining the problem through an economics** lens. There are **three benefits** of such an approach. **First**, many of the drivers of environmental degradation are economic in origin, and the better we understand them, the better we can conserve ecosystems. **Second**, economics offers us a when-to-stop rule, which is equivalent to a when-to-conserve rule. All economic production is based on the transformation of raw materials provided by nature. As the economic system grows in physical size, it necessarily displaces and degrades ecosystems. The marginal benefits of economic growth are diminishing, and the marginal costs of ecological degradation are increasing. Conceptually, we

should stop economic growth and focus on conservation when the two are equal. **Third**, economics can help us understand how to efficiently allocate resources toward conservation (Farley, 2010).

However, field of economics, dominated by neoclassical economics, builds an analytical framework based on **questionable assumptions** and takes an excessively disciplinary and formalistic approach. This **profound failure** could be significantly solved by the TD approach to research, leadership, governance, and university education (Zalanga, 2009, p. 72). Conservation is a complex problem, and analysis from individual disciplinary lenses can make important contributions to conservation only when the resulting **insights are synthesized into a coherent vision of the whole** (Farley, 2010).

Although at the beginning of 21st century economic growth increased, but most of the people were excluded from the benefits of the growth. This is not a bygone problem, but rather it is a problem that continues to be with us in the current era of globalization where there are **much more losers than winners** (Stiglitz, 2006). Nowadays there are overwhelming evidences, that the way in which economics is taught in the universities, and implemented in the market, is incapable of solving global SD problems such as poverty, unemployment, nature conservation, peace, etc. In this context TD institutional environments could play a meaningful role by facilitating TD to penetrate and transform the economic visions (Max-Neef, 2005).

Nicolescu (2002) points out the fact that “there is a direct and unavoidable relation between peace and TD.” Saying that “severely fragmented thought is incompatible with the research of peace on planet Earth“. He states that this fact requires not only the TD evolution of education, but also, the TD evolution of the university itself. We need to implement TD to improve understanding of the social world and of nature. It is clear that if such an effort is not undertaken, we will continue generating ever greater harms to society and to nature, because of our partial, fragmented and limited visions and assumptions (Max-Neef, 2005). The challenge is to practice TD in a systematic institutionalized manner.

## **5.1 United Nations Decade of Education for SD 2005-2014**

The UN DESD (2005-2014) seeks to **integrate values inherent in SD into all aspects of learning** to encourage behavior changes that allow for a more sustainable and just society for all. UNESCO has a **dual role** in relation to translating TD into practice with regards to Education for Sustainable Development (hereinafter: ESD): **first** as a substantive implementer of ESD – accelerating education reforms and coordinating activities of multiple stakeholders to implement ESD at international, regional, and country levels. **Second**, UNESCO also acts as the lead agency in the promotion of the DESD. The Decade offers an opportunity for UNESCO and its partners to advance progress made in human resource development, education and training to ensure results in meeting current and future needs for sustainable futures (UNESCO ESD, 2011).

In relation to DESD a **TD approach is needed at all levels of society** to develop opportunities for a sustainable future based on the concepts of sustainability, equity, justice and peace. TD and

holistic understanding of the world’s problems is the starting point for developing a new global consciousness to drive changes in behavior and lifestyles. Such a perspective is also the basis for the development of options for informed decision-making to manage the transition to sustainability locally, nationally and globally (UNESCO ESD, 2011).

The move toward TD is closely linked with **changes in ways of thinking** about the challenges and changes facing the world. There has been a growing understanding of the complexity and interrelationships of problems such as poverty, wasteful consumption, environmental degradation, urban decay, population growth, health, and the violation of human rights. Addressing these complex problems requires TD and inter-sectoral approaches (UNESCO ESD, 2011).

**TD within UNESCO.** Within UNESCO, TD is meant to bring the work of the organization closer to the realities of its member states and to make UNESCO’s work more relevant and effective in finding solutions to real world problems (UNESCO ESD, 2011).

**The ESD is a unique mechanism within UNESCO to translate TD into practice.** ESD takes full advantage of UNESCO’s long experience, wealth of expertise and contacts in the field of SD by bringing together UNESCO’s sectors such as education, science, culture and communication – in the service of objectives that transcend them all. By interacting among UNESCO’s four fields of competence, as well as through partnerships with other UN agencies, governments and non-governmental organizations (NGOs), and other stakeholders, ESD plays a significant role in adapting UNESCO’s planning and modalities of action to the changing needs of member states (UNESCO ESD, 2011).

*Table 3: Educational shifts proposed by ESD*

<b>From</b>	<b>To</b>
Passing on knowledge	Understanding and getting to the root of issues
Teaching attitudes and values	Encouraging values clarification
Seeing people as the problem	Seeing people as facilitators of change
Sending messages	Dialogue, negotiation and action
Behaving as expert – formal & authoritarian	Acting as a partner – informal & egalitarian
Raising awareness and	Changing the mental models which influence decisions & actions
Changing behavior	More focus on structural and institutional change

*Source: D. Tilbury, Assessing ESD Experiences during the DESD, 2010, p. 15.*

**Education** is a useful tool for **promoting greater consciousness and awareness**. It brings about desired changes in behaviors/lifestyles and is important for developing the knowledge and skills needed for a sustainable future (UNESCO, 1997). ESD includes TD inquiries into environmental, social and cultural issues.

Finally, **learning is regarded as a never-ending process**. The need for learning can be generalized to inquiries relating to all **complex adaptive systems**<sup>17</sup> and has been widely accepted as the essential part of the innovation process in the organizational and management literature (Senge, 1992). Therefore, it is logically expected that ESD is going to continue, with a help of UNESCO, even when DESD 2005–2014 ends.

## 5.2 TD View of Academic/Research Institutions

If universities and research centers intend to be meaningful actors in SD debates, they have to firstly recognize the emergence of a new type of knowledge – TK. The practices of SD suffer from the lack of comprehensive and systematic trainings to foster the core TD competencies (especially in Slovenia). A rigorous change in educational system and approach to education in the field of SD is extremely needed.

Nevertheless, Max-Neef (2005) believes that **radical change of the structure of the universities** is almost impossible. Internal resistances can become too heavy, since it is expected the “feuds” within which academic “prestige” is constructed, will defend themselves against any structural change. It is quite amazing that about **three hundred years ago**, Leibnitz<sup>18</sup> expressed his hostility towards universities, because their organization in terms of **faculties hindered the expansion of knowledge across and beyond disciplines**. Anyway, the change is necessary and it can only come from within the university, through the cooperation between specific academics. Nevertheless, we may notice that such a process is already in the progress.

For **Goethe**<sup>19</sup>: “Science is as much an inner path of spiritual development as it is a discipline aimed at accumulating knowledge [...] It involves not only a rigorous training of our faculties of observation and thinking, but also of other human faculties which can attune us to the spiritual dimension that underlies and interpenetrates the physical; faculties such as **intuition, imagination, ethics, aesthetics, and feeling**”. Science, as Goethe conceived and practiced it, has as its highest goal the arousal of the feeling of wonder (Naydler, 2000).

Werner Heisenberg, one of the fathers of quantum physics, suggested that there is actually no conflict between accepting Goethe’s way of contemplating nature, and the contributions and findings of **modern physics**. For him **both ways are complementary** (Heisenberg, 1952). Heisenberg is in fact **one of the first great scientists of the XX<sup>th</sup> century to advocates Goethe’s scientific contributions**.

The growing rupture in communication is the product of the worsening of rational thought, which manifests itself through the predominance of reductionism and of a binary logic. **It**

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<sup>17</sup> **Complex adaptive systems** are special cases of complex systems. They are complex in that they are dynamic networks of interactions and relationships not aggregations of static entities. They are adaptive in that their individual and collective behavior changes as a result of experience (Complex adaptive systems, 2012).

<sup>18</sup> **Gottfried Wilhelm Leibniz** (sometimes **von Leibniz**) (1646–1716) was a German mathematician and philosopher. He wrote in different languages, primarily in Latin, French, and German (Leibniz, 2012).

<sup>19</sup> **Johann Wolfgang von Goethe** (1749–1832) was a German writer, pictorial artist, biologist, theoretical physicist, and polymath. He is considered the supreme genius of modern German literature (Wolfgang von Goethe, 2011).

**separates** the observer (TD Subject) from the observed (TD Object). Nicolescu says: “The TD education, founded on the methodology of TD, will allow us to **establish links** between persons, facts, images, representations, fields of knowledge and action, to built beings in permanent questioning and permanent integration” (Nicolescu, 2002).

A yin and yang<sup>20</sup>, as suggested by Taoism, in which the yin is analogous to **relational thought** and the yang to **rational thought**, is an ancient philosophy used to describe how opposite forces are interdependent in the natural world, moreover, it explains how they give rise to each other in turn. As Goethe would say logic capable of **harmonizing reason with intuition**. In this last sense, one must recognize that innovators in all fields often rely on intuition in order to reach a solution for problems of their concern. The strange thing is that when they share results with colleagues, the tendency is to **reduce their findings to rational level**. A strange sort of **shyness** seems to prevail in the sense that admitting the contribution of intuition may be perceived as an indecent behavior, not worthy of a true scientist. Einstein says the following: “**The intuitive mind is a sacred gift, and the rational mind is a faithful servant. We have created a society in which we honor the servant and have forgotten the gift**” (Max-Neef, 2005).

Problem-oriented approaches are required to improve our understanding and create new solutions able to sustain ecological systems. This puts a growing demand on university education at undergraduate and graduate levels to prepare students for an TD and global collaborative world (Hammer & Söderqvist, 2001). If TD studies would be used to bring about solutions to complex development challenges, certain **changes have to be taken** (Zalanga, 2009, p. 73):

- **First**, the **structure of the universities** has to change in terms of the reward system, institutional barriers, and the way academic departments and programs are structured;
- **Second**, the content of education must be designed in such a way that students are provided the opportunity to learn how to **practice solving complex problems** by integrating different perspectives;
- **Third**, the educational **curriculum** has to be changed at all levels to enable students develop holistic, reflexive competences and integrative systems thinking skills. Students need to cultivate a curious attitude to life and to develop a peaceful spirit that learns to communicate with other disciplines operating with different jargon and paradigmatic assumptions.

Finally, fundamental reform of educational institutions and pedagogy is necessary in order to create the necessary conditions and requirements for an interdisciplinary and TD working environments (Zalanga, 2009, p. 73).

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<sup>20</sup> In Chinese philosophy, the concept of **yin yang** is used to describe how polar or seemingly contrary forces are interdependent in the natural world, and how they give rise to each other in turn. Opposites thus only exist in relation to each other. Yin and yang are complementary opposites that interact within a greater whole, as part of a dynamic system. Everything has both yin and yang aspects, but in different proportions (Yin and yang concept, 2011).

### 5.3 Evaluating the Quality of the TD Research Endeavors

The SD knowledge generation in contemporary societies is leading to increased theoretical attention being directed at TD as an appropriate response. As TD is a nascent approach to research, there is **not yet a well-established community** of peers experienced in reviewing the quality of TD research endeavors. This means that more formal approaches to quality evaluation may be required. Additionally, because TD research is **broad, diffuse, evolving** and **context specific**, the criteria for quality assessment will arguably be **implicit in the research context** rather than in particular disciplinary frameworks (Wickson, Carew & Russell, 2006).

Evaluators of quality of the TD research endeavors may ask how well the features and challenges of TD have been accounted for, for example (Wickson et al., 2006):

1. **Responsive goals** – a scholar defines goals through ongoing consultation with the problem context and stakeholders. Goals may therefore not be clear from the beginning and **may change** in response to developments over the course of the project;
2. **Broad preparation** – preparation would require accessing and integrating literature and theory **across a broad range of disciplines**, as well as engaging with the problem in its broader context;
3. **Evolving methodology** – an appropriate method for TD research is ideally **epistemologically integrative** and capable of **evolving** in response to a changing research context;
4. **Significant outcome** – the outcome should be capable of satisfying multiple agendas, e.g., be simultaneously socially and environmentally sustainable while economically viable;
5. **Effective communication** – in support of collaborative processes, TD research should establish two way communications with stakeholders over the life of the project;
6. **Communal reflection** – in addition to personal reflection, TD research should include a more communal reflective process – multiple disciplinary and stakeholder perspectives informing and transforming each other throughout the life of the project.

This approach may be more appealing to institutions or individuals that need to **compare** TD research projects. For example, funding institutions may be required to compare and rank competing TD projects. This process could be assisted by the further development of evaluative tools (Wickson et al., 2006). By comparison, Madni (2007, p. 6) introduces a **TD mindset**. It is one that is opened to questioning disciplinary assumptions, and which is willing to reach out to other disciplines to solve problems. Below there are some characteristics of the TD mindset:

- Actively looking for and exploiting **synergies** among disciplines;
  - E.g., decision theory and artificial intelligence.
- Actively seek out appropriate **analogies**;
  - E.g., biological analogy exploitation.
  - E.g., the human immune system can be applied to cybersecurity.
- Frame the problem in a **larger context** to open up collaboration scope;

- E.g., BMW’s concept car designed after a boxfish<sup>21</sup> is a result of collaboration between engineers and marine biologists.
- Examine the problem as an **outsider**; looking beyond entrenched thinking can open up the option space.
- Formulate the problem from **different perspectives**; perspectives could include ethical, moral, technical, organizational, social, etc. dimensions.
- **Envisioning** the outcome or result; a “**reality check**” can cause the relaxation of constraints imposed by an entrenched mindset.
- Strive for **semantic interoperability** among disciplines;
  - develop multi-domain ontologies,
  - reconcile assumptions and theories across disciplines (to the degree possible),
  - create a shared vocabulary to address complex problems,
  - relax disciplinary boundaries to accommodate new concepts.
- Explicitly formulate key **tradeoffs**; force team to open “mental locks” and view problem in a new light.

Accordingly, TD research has to take into account the **complexity** of issues and the complex system of factors that together explain the issue’s current state and its dynamic. It has to be framed in such a way that it can address both **science’s and society’s diverse perceptions** of an issue and can **set aside the idealized context of science** in order to produce practically relevant knowledge (Pohl, 2005, p. 1160). TD research is oriented towards a common interest, i.e., interest that is widely shared within a whole community (Clark, 2002, p. 13).

Next chapter deals with barriers to the TD collaboration in the complex environments and conditions.

## 5.4 Barriers to the TD Collaboration

While the need for TD research in a world facing complex existential problems is very evident, we should not underestimate the barriers that will have to be overcome. Max-Neef (2005) argues that in Darwin’s time, it was possible to write a book that was both a primary **scientific report and a popular bestseller**. Nowadays, that seems like fiction. Not only it is difficult to communicate scientific ideas to the general public, but scientists seemed to have increasing **difficulty communicating with each other**; researchers in different areas of specialization are often unable to understand each other’s papers.

It appears that particularly economists have forgotten that science is also based on empirical observation and therefore ignore the increasing empirical evidence that many of underlying assumptions are wrong. The background of the problem is that universities around the world train students in **isolated disciplines**. Each discipline has its own language, tools, methods, journals, and creates its own metaphors. Thus, the same words mean different things in different

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<sup>21</sup> The **boxfish** (lat. *Ostracion cubicus*) of the genus *Ostracion* can be found in reefs throughout the Pacific Ocean, Indian Ocean as well as the south eastern Atlantic Ocean. It reaches a maximum length of 45 cm (Boxfish, 2011).

disciplines (Hammer & Söderqvist, 2001). Faculty members are hired by disciplinary departments and, in most cases, must publish in disciplinary journals if they hope to get tenure. Grant proposals are reviewed by disciplinary peers and too often they reject what they cannot understand. With incentives to go beyond the narrow confines of a given discipline, academics become uncomfortable with changing their disciplinary jargon that only their colleagues can understand. **This shields them from criticism**, because potential critics must spend years learning the language before they are qualified to critique specialized endeavor, and critics are of course unlikely to invest so much effort (Farley, 2010).

**Institutional barriers** between university departments constitute an obstacle to develop full TD educational programs. Introducing TD elements by mixing students from different courses in joint exercises may be one way to launch TD approach in universities (Hammer & Söderqvist, 2001). Anyway, there are also barriers within the scientific community where many scientists prefer to continue their basic research and not confront issues and questions **raised by non-scientists**. Tackling complex public issues will need input from scientists, resulting in a different type of research (Hirsch Hadorn et al., 2008, p. vii).

Excessive retreat into a single discipline is comparable with **autism**<sup>22</sup>. A focus on theory over practical applications too often divorces a discipline from reality. Economists and others are excessively attached to their simplistic methodologies, which do not correspond to understanding of complex systems (Daly & Farley, 2004). At least within the natural sciences, **consilience**<sup>23</sup> is occurring in a way that the sciences do not contradict each other, e.g., biologists understand that their discipline depends on the rules of chemistry, which, in turn, depends on the laws of physics etc. (Wilson, 1998).

Finally, capitalistic logic creates relations and relationships between people that are not in favor of constructive TD cooperation; it rather prepares territory for a game of poker as described by **John Nash's** in his **Game Theory**. Particularly business world acts according to the principles of Game Theory which rest on the foundations of the Cold war. Therefore, rules of behavior are similar to a poker game where suspiciousness, distrust, egoistic interests, strict rationality are basic assumptions. It is clear that under such conditions TD cooperation is much hindered. There are also numerous other general obstacles for TD cooperation including the lack of human awareness of the issues, the absence of political interests or the opposition of entrenched interests, and the inadequacy of institutional mechanisms to create integrative collaborative environment.

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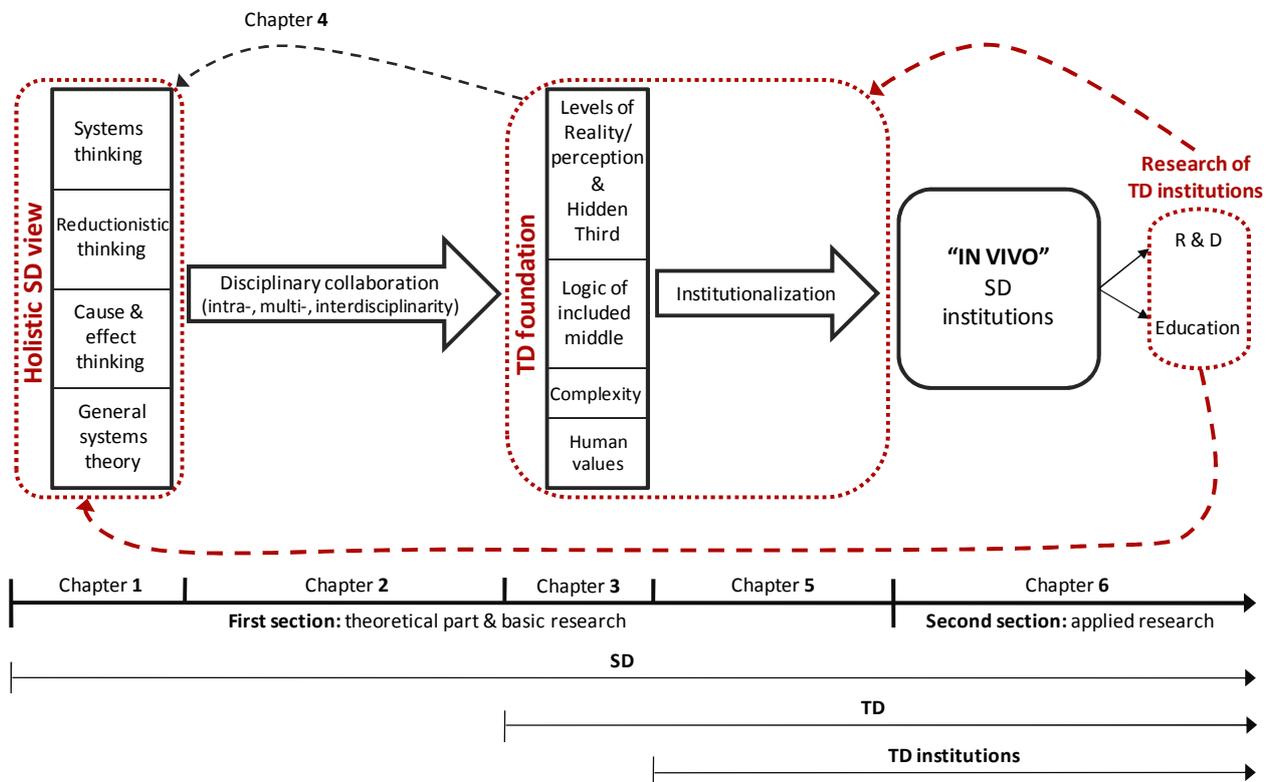
<sup>22</sup> **Autism** - A disorder characterized by absorption in self-centered subjective mental activity, deficits in communication and social interaction, withdrawal from reality, and abnormal behavior, such as **excessive attachment to certain objects** (Farley, 2010).

<sup>23</sup> **Consilience**, or the unity of knowledge (literally a "jumping together" of knowledge), has its roots in the ancient Greek concept of an intrinsic orderliness that governs our cosmos. "Consilience: The Unity of Knowledge" is a 1998 book by biologist E. O. Wilson. In this book, Wilson discusses methods that have been used to unite the sciences and might in the future unite them with the humanities. Wilson prefers and uses the term *consilience* to describe the **synthesis of knowledge from different specialized fields of human endeavor** (Consilience, 2011).

## 6 RESEARCH OF THE TD INSTITUTIONS

The applied research of TD institutions is causally related to the first section (the theoretical part and the basic research) of the master thesis. In Figure 14, the feedback loops are marked with red arrows. Analysis of TD institutions is based on the perspectives of the both concepts of SD and of the concept of TD, which are unified in Chapter 4. This chapter is therefore basis for the analysis of existing TD institutions and for the selection of “IN VIVO” institutions. The current chapter is divided into **three broad parts**: presentation of basic research information, followed by depiction of research results and the synthesis of the main findings including hypothesis verification.

Figure 14: Mind-map of the research of TD institutions



In the available literature I have come across many concerns about current status of cross-disciplinary, especially TD institutional collaboration. For instance, Shaw and Kim (2008) in the “Report from the International Commission on Education for SD Practice” at the Earth Institute at Columbia University note that although there is **great need for “generalist” SD practitioners**, we are still witnessing lack of appropriate TD (or even interdisciplinary) undergraduate and graduate educational programs. The lack of cross-DK and skills within the field of SD highlights the need for a new type of “generalist” practitioners, those who understand the complex interactions among SD fields and are able to coordinate the insights offered by subject-specific specialists. Generalists are needed to develop integrated policy solutions that are scientifically, politically and contextually grounded (Shaw & Kim, 2008).

While many universities around the world offer graduate degree programs that have a “development” label, programs typically focus on either social sciences or environmental sciences, therefore they offer only a few opportunities for education of systematic management. Across these programs, there are no consistent standards for prerequisite trainings, core curriculum or program length. While existing degree programs offer subsets of the required skills, there are no programs that systematically provide students with the **holistic skills and knowledge** (Shaw & Kim, 2008). Although such concerns were expressed in the year 2008, my goal of the applied research is to find what Shaw and Kim may not have found during their investigations, i.e., **“IN VIVO” institutions worldwide**.

Shaw and Kim (2008) also argue that: “Because of lack of degree programs focused on cross-disciplinary learning, development professionals have almost no opportunities for upgrading their skills throughout their careers. Executive education programs are typically focused on management techniques rather than substantive, holistic trainings [...] since training programs generally **do not provide staff and management with cross-disciplinary learning requirements**”.

However, since the concept of TD is in the nascent phase, I have not been able to find any comprehensive research of TD institutions, especially those institutions with the focus on SD field. In the following research I try to find them by using of the World Wide Web.

## **6.1 Essential Research Information**

At the beginning of the research the following essential research information were set.

**Research Purpose and Objectives.** The purpose of the research is to find TD institutions around the world and to verify whether they operate according to the principles of TD foundation. The focus is on the SD field, while not excluding “Other” areas of science gathered in the following area groups: Medicine and biology, Engineering, natural sciences and mathematics, Social sciences, and Humanities.

A fundamental goal is to **select** institutions which best suit the definition of TD collaboration, i.e., so-called **“IN VIVO” institutions**, and to find out which factors importantly influence the degree of TD integration. While comparing with other institutions, “IN VIVO” would serve as an object of reference. Besides, as research goal is also considered the verifications of the hypothesis.

### **Research Hypotheses:**

**Hypothesis 1:** Most TD institutions were recently established and there is an upward trend in the establishment of institutions.

**Hypothesis 2:** The main activity of TD institutions is research and much less education.

**Hypothesis 3:** More than half of the TD institutions are located in North America, fewer in Europe and even fewer in Asia and Australia.

**Hypothesis 4:** Because TD is in nascent phase of development, institutions implement TD approach in various ways. Less than one quarter of TD institutions fully adopt and implement the concept of TD introduced in the first section of the master thesis.

**Hypothesis 5:** A strong correlation between SD institutions with the concept of TD exists. Institutions directly related to SD predominantly use a holistic TD approach that integrates economy, ecosphere, and sociosphere. In such institutions the concept of TD is the most consistently applied, unlike in other institutions that are indirectly related to SD.

**Research Limitations.** Since I have not been able to find any similar comprehensive research, it is impossible to compare my results with the results of any other research.

Many times during the research analysis there was a problem with identification of values of TD institutions. In their vision and mission statements they often claim that an institution is committed to values. But there was rarely expressed to what kind of values they are committed to. This limitation is directly related to the parameter “**degree of TD integration**” which is among all the most relevant.

However, I have been also limited by the financial resources, thus the best way to collect the necessary data was by using of World Wide Web and the internet search engine Google. The data is thus gathered only from the internet sources. Consequently, the institutions which do not have web sites, or other internet publications, are automatically excluded.

In the next chapter there is presented methodology of the research and the methods used to implement the research.

## **6.2 Methodology of the Research**

According to the nature of the research object, i.e., a TD institution, I have decided to use qualitative interpretative analysis method. This type of analysis is the most suitable for sorting and filtering the specific data that is collected from the institution’s web sites. The data obtained is mostly in qualitative form and much less in quantitative. Although, there are more or less qualitative parameters the results are largely presented in the graphic forms. At the end of the analysis the results are synthesized by critical interpretive synthesis method; research results are more extensively discussed from a critical point of view.

### **Steps or Milestones of the Research Process:**

**Step 1:** Determined parameters for analysis;

**Step 2:** Defined groups of Google keywords;

**Step 3:** Identified TD institutions;

**Step 4:** Institutions sorted in five areas of science;

**Step 5:** Data for all parameters found on institution’s web sites;

**Step 6:** Graphical analysis and identification of key findings.

## **Step 1: DETERMINED PARAMETERS FOR ANALYSIS**

**In the research there are several parameters analyzed:**

1. Title of institution (including parent institution);
2. Founding date;
3. Type of institution;
4. Predominant institution's activity;
5. Degree of TD integration;
6. Areas of SD;
7. Location;
8. Title of a website;
9. Group of Google keywords;
10. Primary area of science.

Because parameters are mostly in **qualitative form**, they are transformed into **quantitative forms** with a single purpose to implement analysis with a help of the graphical figures. Below there are quantitative and qualitative values of the parameters presented.

**Parameter no. 2 – Founding date;** groups: 1985–1989; 1990–1994; 1995–1999; 2000–2004; 2005–2009; 2010 or later.

**Parameter no. 3 – Type of institution:**

- 1: Single university;
- 2: Multi-university network;
- 3: Multi-research center network;
- 4: Research centers embedded in a university;
- 5: Research centers not embedded in a university;
- 6: Other.

**Parameter no. 4 – Predominant institution's activity:**

- 1: Undergraduate education;
- 2: Graduate (masters either/or doctoral either/or postdoctoral) education;
- 3: Professional (certificate) programs, i.e., short courses, workshops, independent courses, consultations;
- 4: Research.

**Parameter no. 5 – Degree of TD integration:**

- 1: Almost no TD integration – “**IN VITRO**”;
- 2: **Some/moderate** TD integration (disciplines from SD field are integrated to create new concepts/models which influence decisions & actions – similar to interdisciplinary integration);

3: Strong TD integration (integration according to the principles of TD foundation – integrating different stakeholders, adopting systems thinking approach, complexity theory, chaos theory, Apollonian values, TD Subject, and/or the rest of TD pillars) – **“IN VIVO”**.

These groups are created according to the factors presented in Table 4 below and according to the theoretical part as well as basic research in the first section of the master thesis. Especially understandings from Chapter 5.3, i.e., “Evaluating the Quality of the TD Research Endeavors”, are considered in the definition of this parameter.

*Table 4: Factors that determine degree of TD integration*

	<b>DK (no TD integration)</b>	<b>TK (TD integration)</b>
<b>Attitude</b>	“IN VITRO”	“IN VIVO”
<b>Logic</b>	Binary logic	Included middle logic
<b>Values</b>	Exclusion of values	Inclusion of values
<b>Communication</b>	Sending messages	Dialogue, negotiation and action
<b>Object/Subject</b>	External world – Object	Correspondence between external world (Object) and internal world (Subject)
<b>Knowledge vs. Understanding</b>	Passing on knowledge	Understanding and changing the mental models which influence decisions & actions
<b>Intelligence</b>	Analytic intelligence	New type of intelligence – harmony between mind, feelings and body
<b>Orientation</b>	Oriented towards power and possession (Dionysian values)	Oriented towards astonishment and sharing (Apollonian values)
<b>Behavior</b>	Behaving as expert – formal & authoritarian	Acting as a partner – informal & egalitarian
<b>No. of Collaborating Disciplines</b>	One discipline	Two or more disciplines

*Source: Adapted from B. Nicolescu, Manifesto of Transdisciplinarity, 2002, p. 153; D. Tilbury, Assessing ESD Experiences during the DESD, 2001, p. 15.*

Accordingly, for the research purposes there are **three essential features of “IN VIVO” institutions**:

1. All areas of SD (economy, sociosphere and ecosphere) are integrated;
2. They integrate also different nonacademic stakeholders (civil society);
3. They adopt systems thinking approach or/and complexity theory or/and chaos theory or/and Apollonian values or/and TD Subject, etc. (see Table 4).

Institutions with **some or moderate TD integration** characteristics integrate two or more areas of SD, but have only partial characteristics of to the second and third feature of the “IN VIVO” institutions. Disciplines from two or more SD areas are integrated to create new concepts/models which influence decisions & actions. Such integrations approach is similar to interdisciplinary integration (see Chapter 2.1). Contrary, **“IN VITRO”** institutions consider only one area of SD and usually do not pay greater attention to TK. They declare themselves TD institutions, but

available information on their web sites prove the contrary, that is, intradisciplinary and multidisciplinary integration.

**Parameter no. 6 – Areas of SD:**

- 1: Economy (human-made capital; producer and consumer goods & services; labor);
- 2: Ecosphere (planetary ecosystem, natural capital – source, sink and life-support service);
- 3: Sociosphere (institutions, customs, norms, human values, knowledge, beliefs, human beings interrelationships, etc.);
- 4: Economy & Ecosphere (1 + 2);
- 5: Economy & Sociosphere (1 + 3);
- 6: Ecosphere & Sociosphere (2 + 3);
- 7: Economy & Ecosphere & Sociosphere (1 + 2 + 3).

The predominant areas of SD of a TD institution are mostly determined by reviewing institution’s mission, vision and values statements. There is an assumption: “**Any institution requiring funding is at least indirectly affected by economics** and consequently deals with economics”.

**Parameter no. 7 – Locations;** institutions are grouped in the following geographical areas: North America, Europe, Japan, Australia, South Africa, Russia;

**Parameter no. 10 – Primary area of science;** these groups are created with regard to Swiss Academies of Arts and Sciences (see Appendix 7):

*Table 5: Structure of the areas of science*

Areas of science		
	SD field	“OTHER” areas of science
1.	Economy	Medicine and biology
2.	Ecosphere	Engineering, natural sciences and mathematics
3.	Sociosphere	Social sciences
4.		Humanities

**Step 2: DEFINED GROUPS OF GOOGLE KEYWORDS**

With the help of the Google search engine TD institutions were found around the world. The process of defining Google keyword groups is a strictly defined process. At the beginning keywords are specified and grouped in a so-called “**Filter groups**”.

Table 6: Keywords for selecting TD institutions

	<b>Filter 1</b>	<b>Filter 2</b>	<b>Filter 3</b>	<b>Filter 4</b>
	<b>TD</b>	<b>Type of institution</b>	<b>Field of collaboration</b>	<b>Activity/Service</b>
1.	“transdisciplinary”	“institute”	“sustainability”	“studies”
2.	“transdisciplinarity”	“university”	“sustainable development”	“training”
3.		“college”	“ecological sustainable development”	“educational program”
4.		“academy”	“conservation development”	“course”
5.		“center”	“environmental”	“teaching”
6.		“organization”		“learning”
7.				“education”

The combinations of Google keywords are gathered in the next three groups of Google keywords:

1. **Filters 1 & 2:** “transdisciplinary” transdisciplinarity OR institute OR university OR college OR academy OR center OR organization;
2. **Filters 1, 2 & 3:** “transdisciplinary” transdisciplinarity OR institute OR university OR college OR academy OR center OR organization OR sustainability OR “sustainable development” OR “ecological sustainable development” OR “conservation development” OR environmental;
3. **Filters 1, 2, 3 & 4:** “transdisciplinary” transdisciplinarity OR institute OR university OR college OR academy OR center OR organization OR sustainability OR “sustainable development” OR “ecological sustainable development” OR “conservation development” OR environmental OR studies OR training OR “educational program” OR course OR teaching OR learning OR education.

### **Step 3: IDENTIFIED TD INSTITUTIONS**

In this step institutions are selected from lists of Google hits. For every Group of Google keywords there are first 200 hits reviewed and the institutions are selected according to qualitative judgment based on theoretical understandings described in the first section of the master thesis. Hyperlinks on reviewed web sites, to access other web sites, are also taken into account.

**Step 4** and **Step 5** are presented in two extensive tables in Appendices 7 & 8. **Step 6** follows in the next Chapter 6.3, and represents graphical analysis with identification of key findings.

## 6.3 Key Findings of the Research Analysis

The research results are located in two parts of the master thesis. In the body text of the current chapter there are located the most important research analysis and the main findings. In the appendices there are basically located two tables containing main source of research data (see Table 14 and Table 15). In **Table 14** there is a data of institutions from SD field; whereas, in **Table 15** there is data of institutions from the “Other” areas of science sorted in four areas groups. Appendices 9 and 10 contain some statistical research results and a part of “IN VIVO” institutions analysis.

Current chapter has four parts. First part deals with the analysis of institutions in all areas of science, second part with the analysis of SD institutions, and third part with analysis of SD institutions in relation to institutions in the “Other” areas of science. Last part presents the “IN VIVO” institutions analysis, namely, analysis of institutions which best fit TD skeleton.

### 6.3.1 Analysis of Institutions in All Groups of Science

In the research there are in total 83 institutions included. Most of them (70%) have been found by using first group of Google keywords and only 6% by using third group (see Table 7). **Second and third groups of Google keywords have search hits only of institutions dealing with SD field.** Therefore, all institutions in the “Other” areas of science have been found by using only first group of Google keywords.

The focal point is to find institutions **occupied directly by SD** activities, therefore the Google search engine has found in total 45 of them, which is 54% out of all institutions analyzed. However, in the research there are included also institutions that are **indirectly related to SD**. They are grouped into four areas, i.e., Medicine and biology (25%), Engineering, natural sciences and mathematics (10%), Humanities (7%), and Social sciences area (4%). Interesting is, that Medicine and biology area has in the first group of Google keywords more hits than SD field.

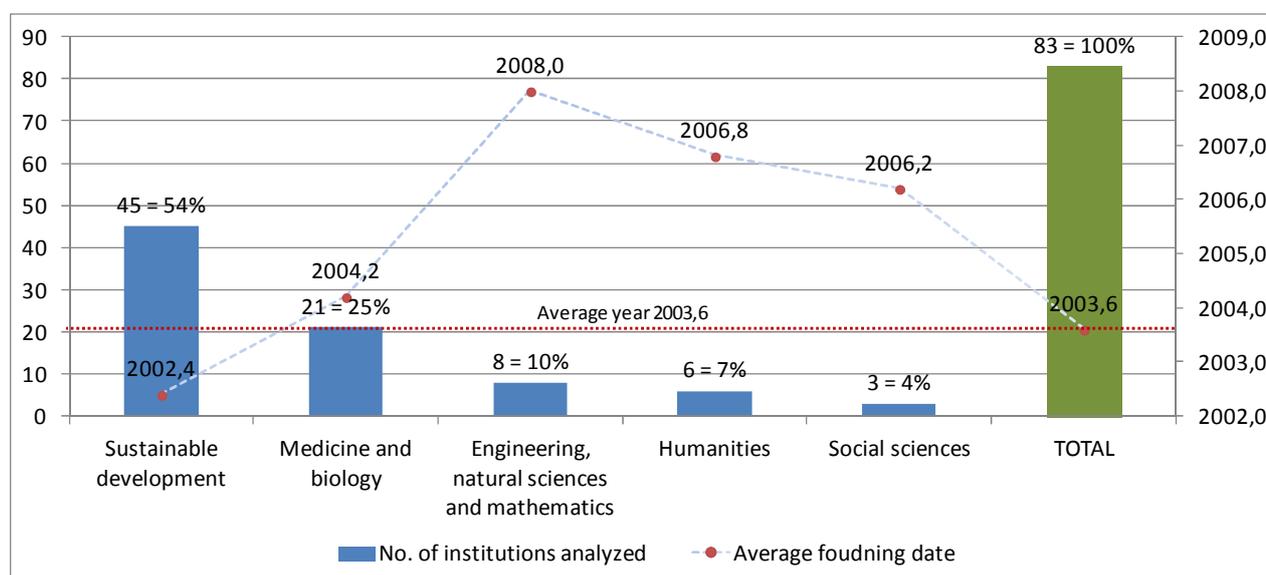
It is quite surprising that there are more (for 3 percentage points) institutions grouped in Humanities than in Social sciences. Nevertheless, it has to be understood that institutions are grouped based on their **primary area** of science; therefore their **secondary areas are not considered**. The big majority of them are infiltrated with various secondary areas of science. Especially economics (Social sciences group) is respected by most institutions as secondary area. **While analyzing institutions from the SD field of science, also secondary areas are considered.**

Table 7: Number of institutions analyzed

		Groups of Google keywords			Total	Total %
		Group 1	Group 2	Group 3		
SD field		20	20	5	45	54%
“OTHER” areas of science	Medicine and biology	21	/	/	21	25%
	Engineering, natural sciences and mathematics	8	/	/	8	10%
	Humanities	6	/	/	6	7%
	Social sciences	3	/	/	3	4%
<b>Total</b>		58	20	5	<b>83</b>	<b>100%</b>
<b>Total %</b>		70%	24%	6%	100%	

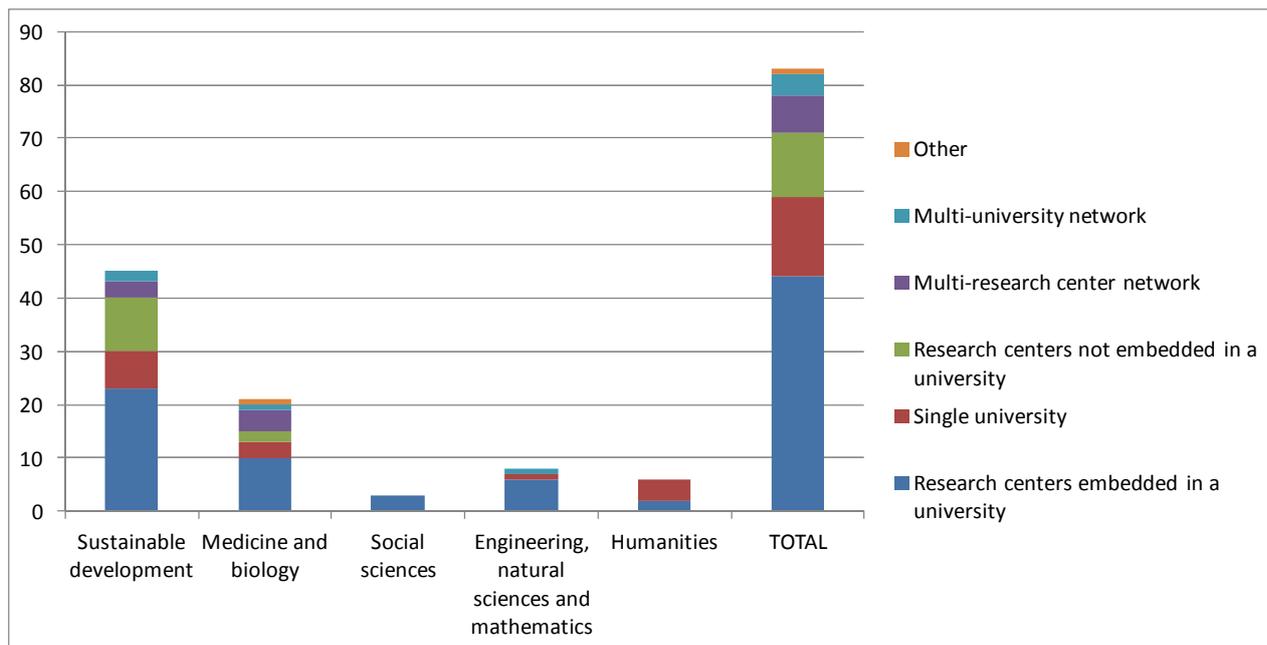
On average a TD institution was established in the years **between 2003 and 2004**; this information signals that the concept of TD is really in nascent phase of development. The oldest institution analyzed is “**CIRET – International Center for Transdisciplinary Research**” which is a non-profit organization in the SD field. It was established in the year **1987** in Paris by Nicolescu Basarab. According to the chart below first TD institutions were established in the field of SD (on average in the year 2002), followed by Medicine and biology (year 2004). Recently, on average in the year 2008, institutions in the Engineering, natural sciences and mathematics were established.

Figure 15: Scientific filed groups with relation to year of establishment



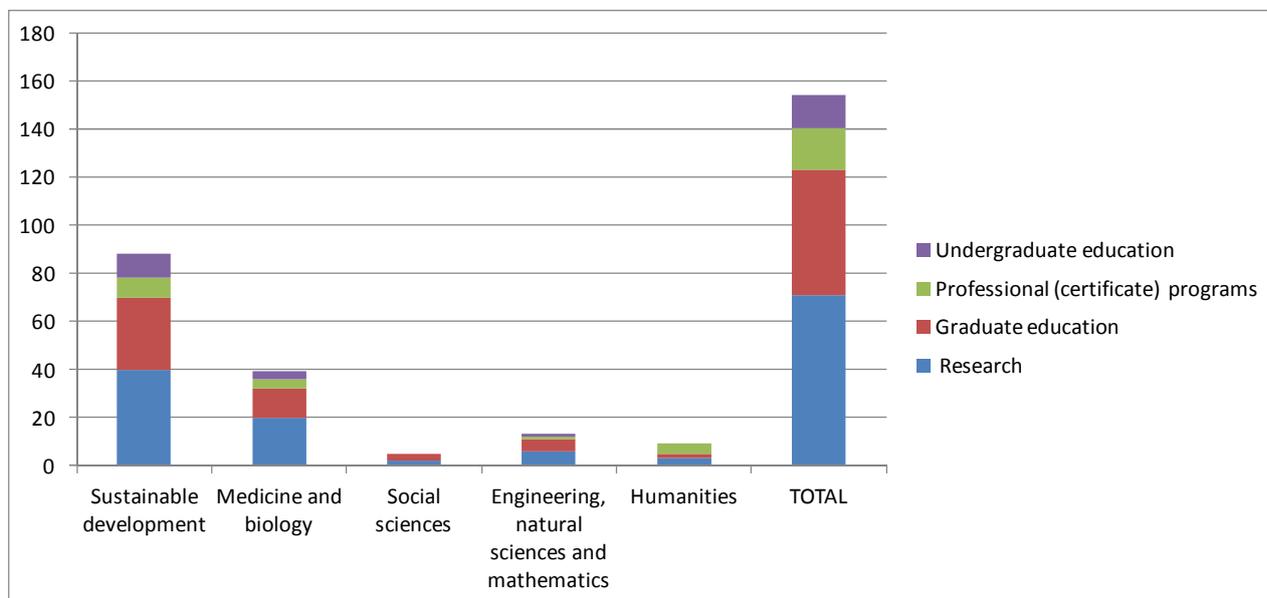
However, sometimes it is quite difficult to identify primary institution’s area. Contemporary services and products have become integrated and regularly traverse disciplinary boundaries.

Figure 16: Type of institutions in different areas of science



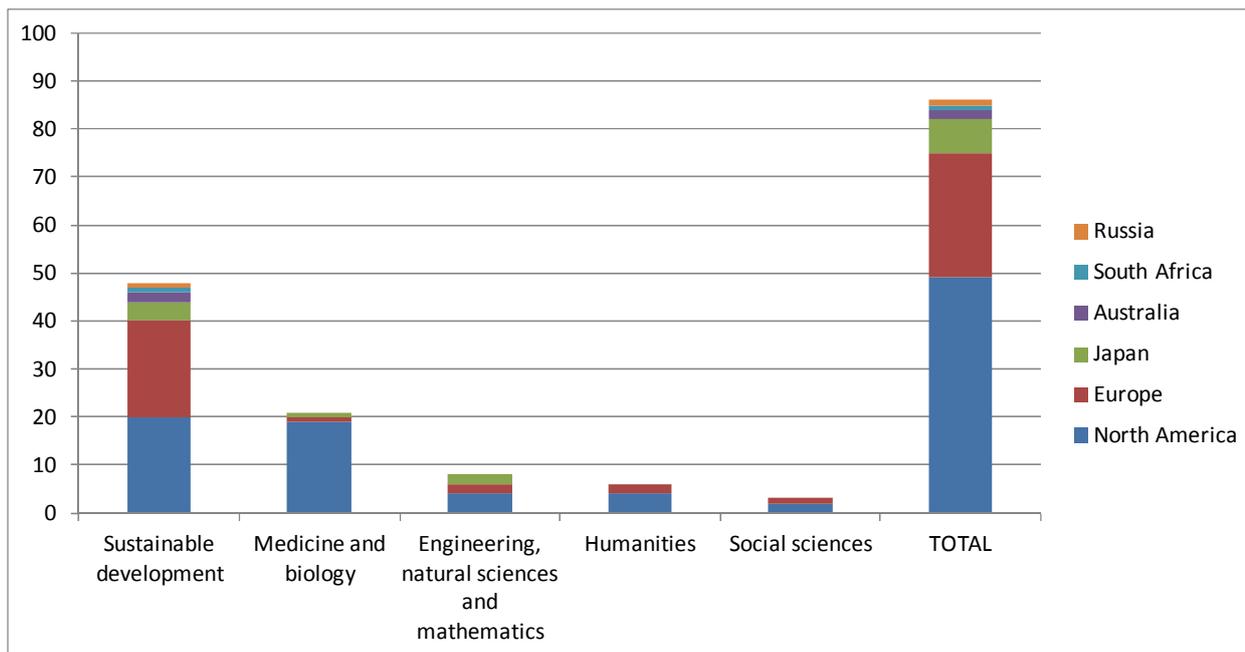
The predominant type of institution is Research center embedded in a university in total there are 53% of them. This type is followed by Single university (18%), than Research centers not embedded in a university (14%). Much fewer there are Multi-research center networks and Multi-university networks. This proportion of institution types in total is similar to proportion in the field of SD, Medicine and biology and also other areas.

Figure 17: Activities of institutions in different areas of science



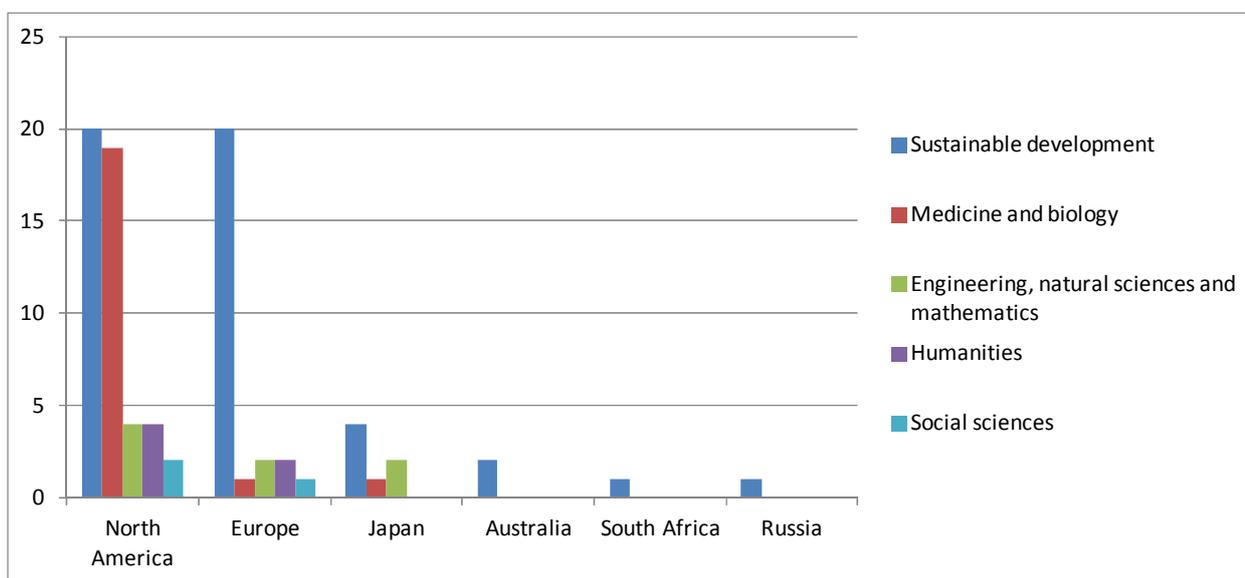
In total, the majority of institutions are active in research (46%) and in graduate education (34%), particularly in doctoral and postdoctoral education. Similar proportion is evident also in the groups with a bigger number of institutions.

Figure 18: Location of institutions by different areas of science



Among all institutions, there are more than half of the institutions (57%) located in North America, primarily in the USA. In the Medicine and biology area 90% of institutions are located in North America. Nevertheless, institutions active in **SD field** are by the same proportion located in **Europe** (42%) and **North America** (42%).

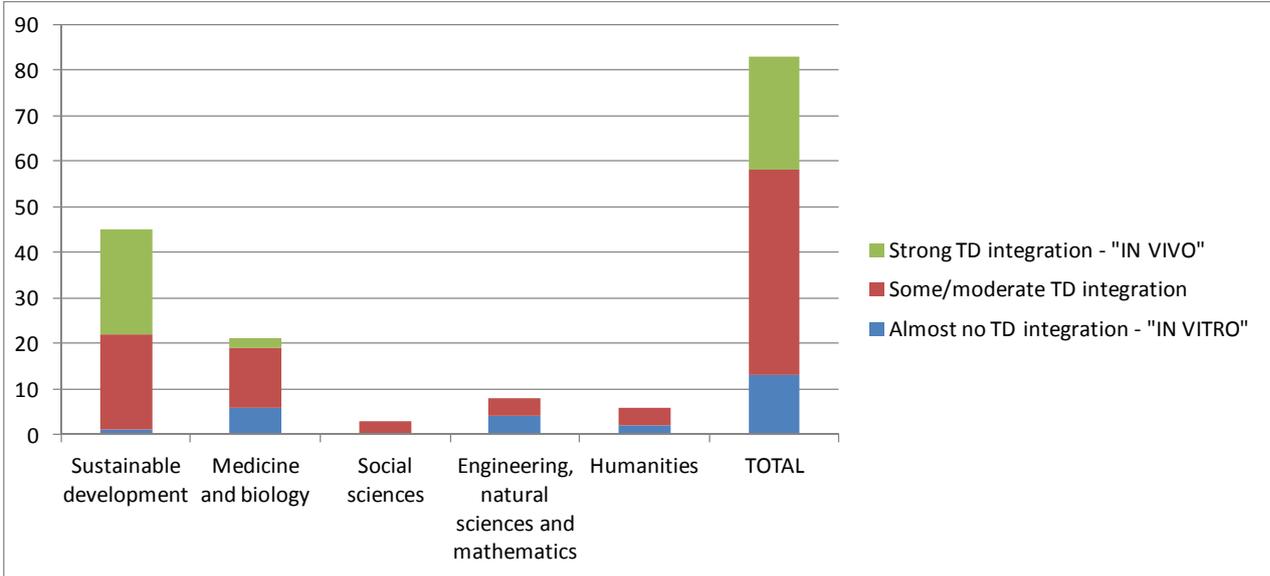
Figure 19: Areas of science in relation to location of institutions



If we switch axes of the Chart 20 we get Chart 21. North America, i.e., **USA and Canada**, are predominant locations of TD institutions. Together with **Europe** there are 87% of all institutions active in these two continents. In Japan there are active only 8% of TD institutions, together in Australia, South Africa and Russia only 5%. The role of Japan should not be neglected, since

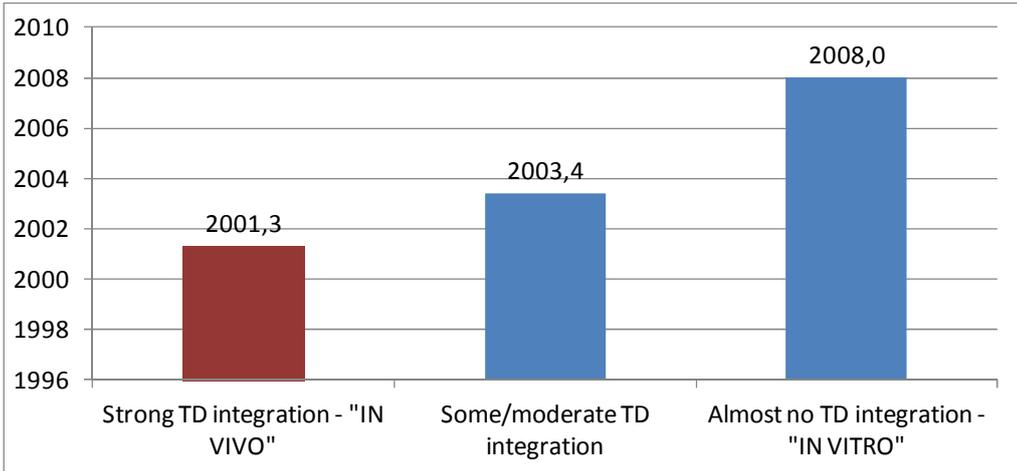
there are 7 TD institutions active mostly in SD (4 institutions), Engineering, natural sciences and mathematics (2 institutions) and one institution in Medicine and biology.

Figure 20: Degree of TD integration by areas of science



In total 64% of institutions apply some or moderate TD integration. Almost one-third (30%) of institutions carry out activities that represent “strong TD integration” with inclusion of different stakeholders, systems thinking approach with respect to complexity, Apollonian values, and the TD Subject. **The biggest proportion (51%) of “IN VIVO” integration is present in the SD field.**

Figure 21: Degree of integration by the average year of establishment



Institutions with characteristic of strong or “IN VIVO” TD integration were on average established in the **year 2001**. On average two years later there were established institutions with some or moderate TD integration activities. The group of institutions occupied by “IN VITRO” integration was on average established in **2008**. It seems that institutions created in the resent times **lose their comprehensive view of the concept of TD.**

Figure 22: Degree of integration by location and by year of establishment

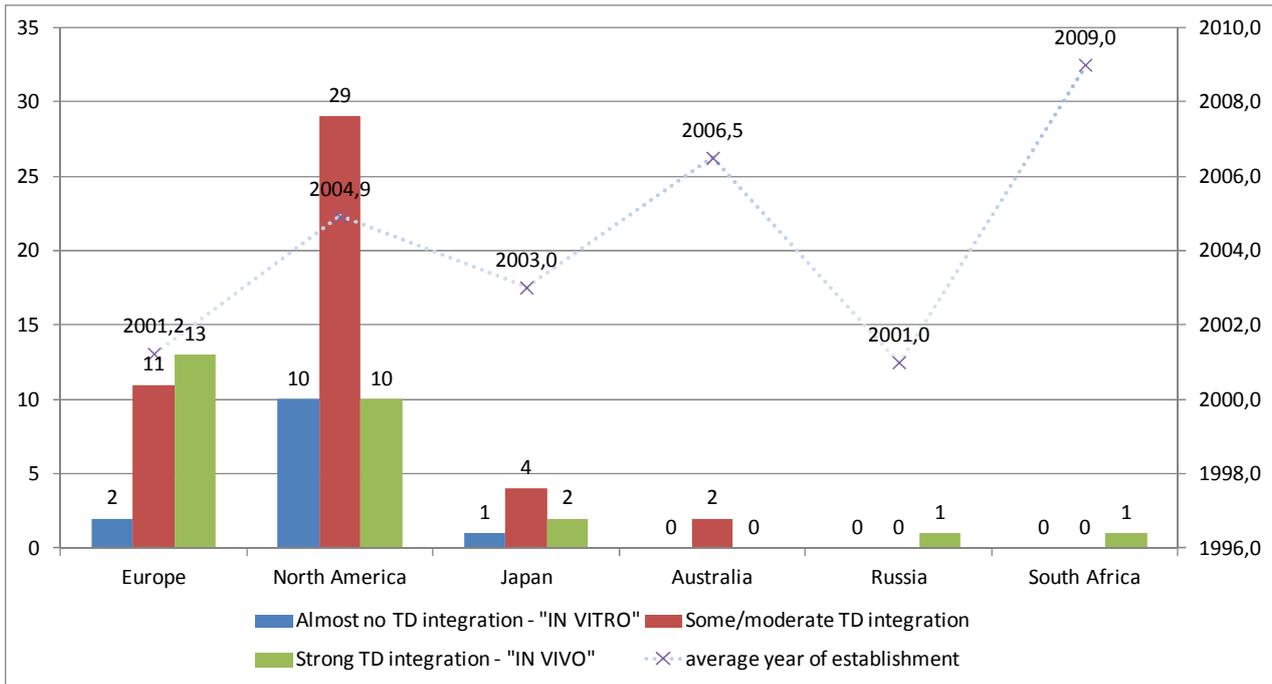
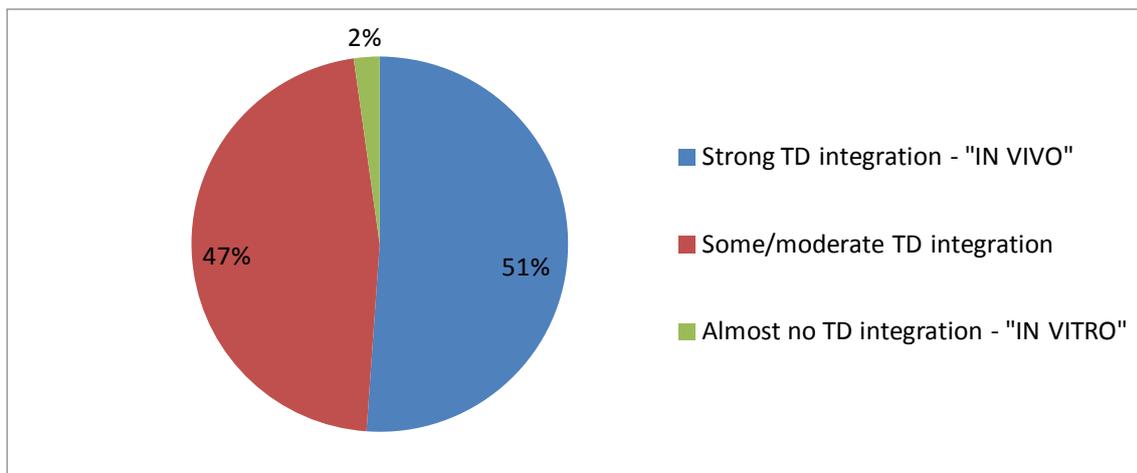


Figure 22 shows that Europe has the biggest number (13) of “IN VIVO” institutions even though North America has in total 23 institutions more than Europe. North America has 3 “IN VIVO” institutions fewer than Europe. On average first TD institutions were established in Europe and one in Russia.

### 6.3.2 Analysis of Institutions in the SD Field

In this part of analysis there is among all areas of science only SD field involved; all other areas are excluded from the analysis.

Figure 23: Degree of integration of SD institutions

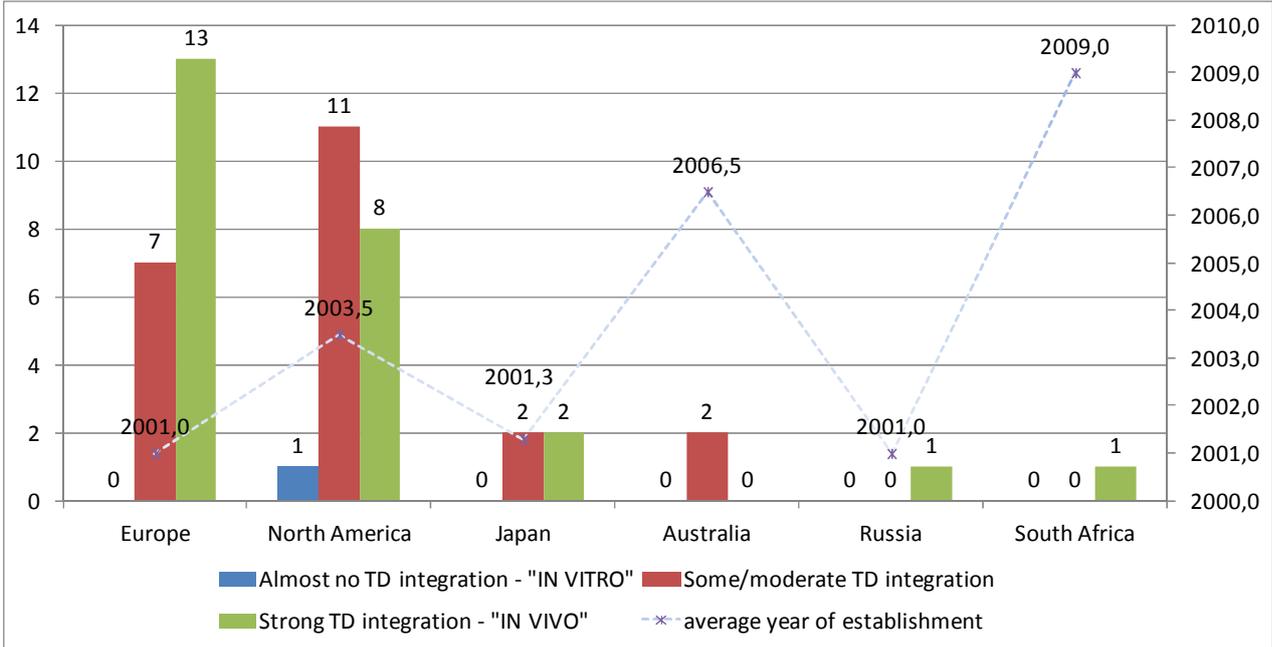


SD field has the largest percentage of institutions with “strong TD integration”. As shown on Figure 23, only 2% of all SD institutions are considered to be occupied by “IN VITRO”

activities. Some or moderate TD integration is identified in case of 47% of institutions in the SD field.

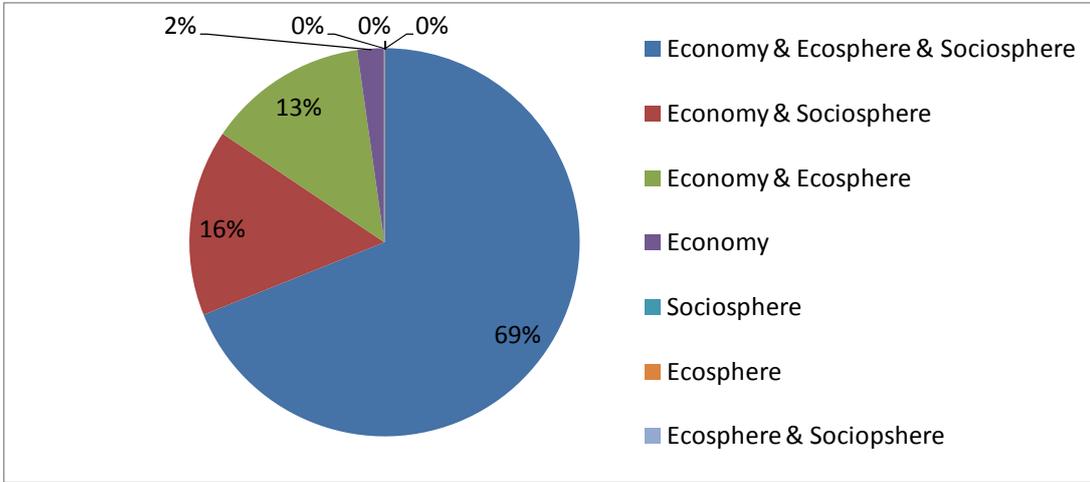
According to Figure 24 below, on average first sustainable TD institutions were established in Europe (in 2001), a bit later in Japan, in North America they were on average established during the years 2003 and 2004. Although both, North America and Europe, have the same number of SD institutions (20 institutions) there are in Europe located more “IN VIVO” institutions; in Europe there are 13 institutions with “strong TD integration” while in North America only 8. In Japan there are two “IN VIVO” institutions.

Figure 24: Degree of TD integration by location and by the year of establishment



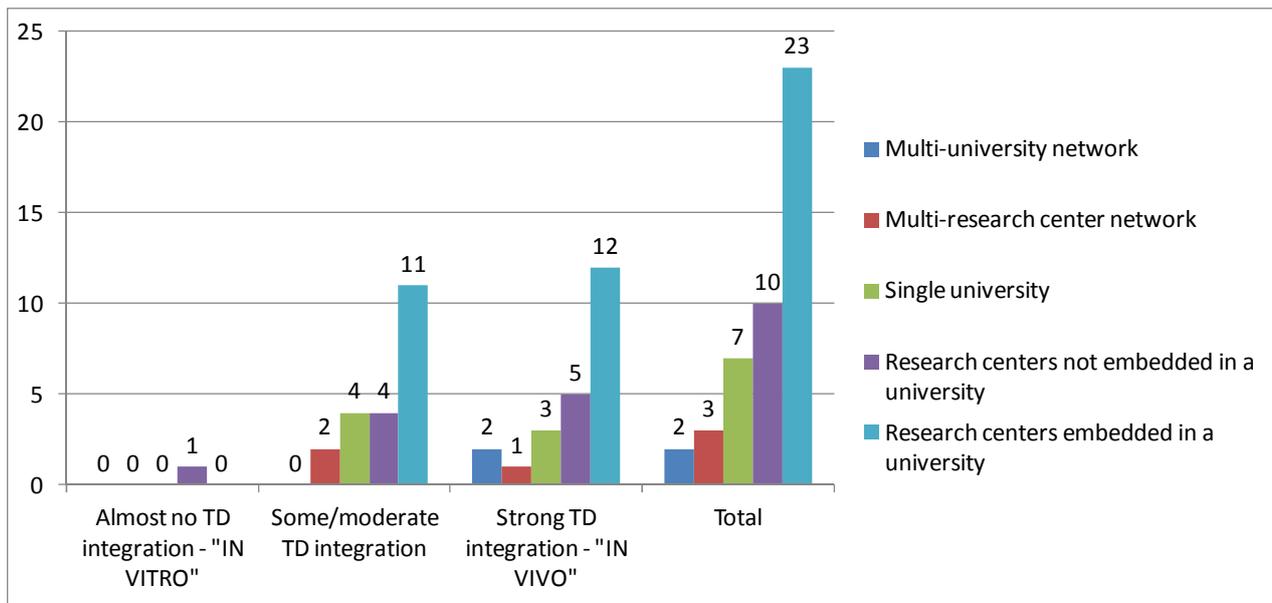
From the Figure 25 below it is clear that SD field in the greatest extent integrates all of the three major areas of SD, i.e., economy, ecosphere, and sociosphere.

Figure 25: Interest of SD institutions in SD areas



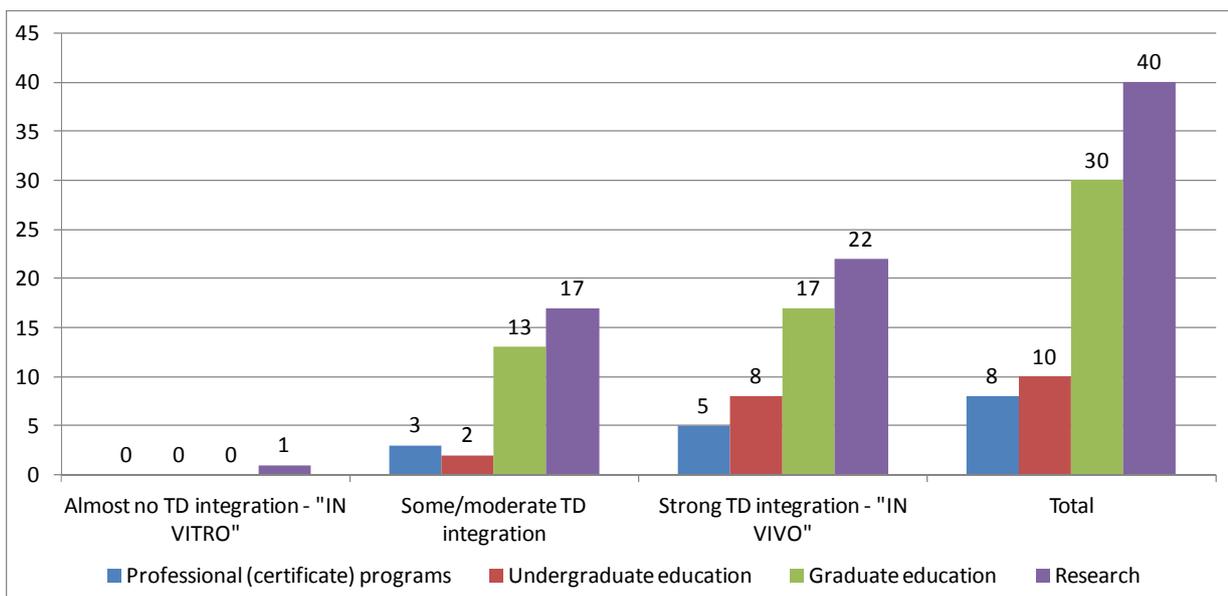
However, there are few SD institutions that integrate all the areas of SD, but do not have attributes of “strong TD integration”, because they do not integrate different stakeholders or systems thinking approach or complexity or Apollonian values or TD Subject, etc. This is why 69% of SD institutions are interested in all areas of SD, but only 51% have characteristics of “IN VIVO” institutions. Subsequently, **18% of SD institutions integrate all SD areas, but do not fulfill the requirements for “strong TD integration”**. Vice versa, all “IN VIVO” institutions are interested in all three SD areas; integrating all SD areas is necessary but not sufficient condition for “IN VIVO” integration.

Figure 26: Degree of TD integration in accordance to the type of SD institutions



The structure of different types of institutions is quite similar in the case of strong and moderate TD integration. It is also not much different while considering all SD institutions together. Thus we cannot conclude that this parameter importantly influence the degree of TD integration. The predominant type of SD institutions is research center embedded in a university.

Figure 27: Activities of SD institution in relation to the degree of TD integration

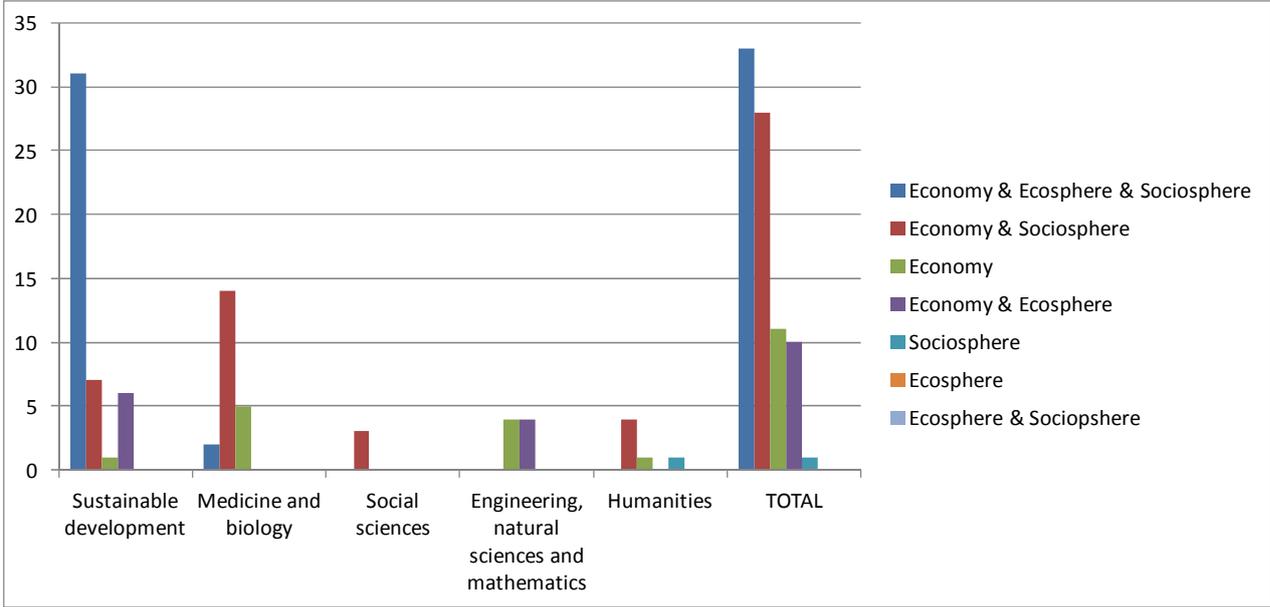


The structure of institution’s activities shows us that sustainable TD institutions are primarily involved in research activities and graduate education. This applies also for institutions with moderate and strong TD integration; therefore we cannot claim that type of SD institutions activities influence the degree of TD integration.

### 6.3.3 SD Institutions vs. “Other” Areas of Science Institutions

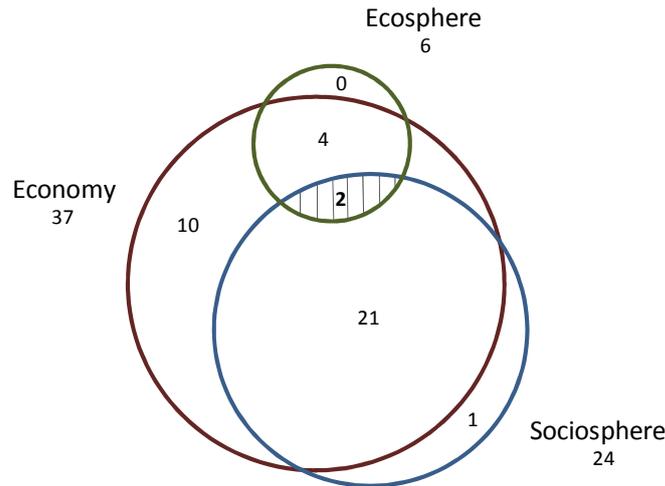
The figures of this Chapter provide focused comparison between SD institutions and institutions in the “Other” areas of science (Medicine and biology, Social sciences, Engineering, natural sciences and mathematic and Humanities). Based on the graphical figures the textual analysis is provided.

Figure 28: Interest of different areas of science in the areas of SD



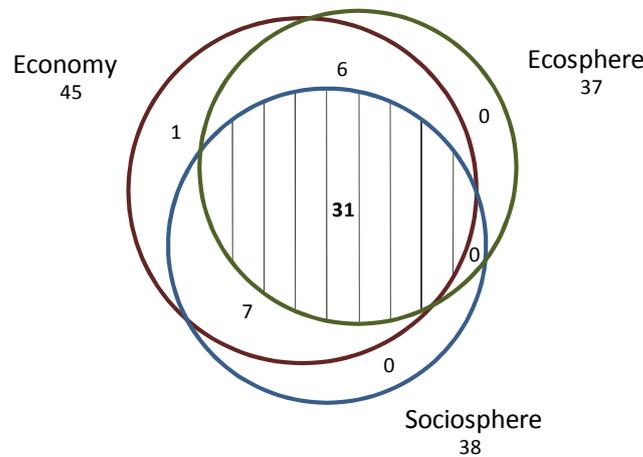
Far the most integrative area is SD and much less Medicine and biology (only 2 institutions out of 21 (9%) integrate all the three areas of SD). Moreover, other areas do not even contain institution interested in all three SD areas at the same time. In total **40% of all TD institutions incorporate economy, ecosphere and sociosphere**. In case of SD institutions this percentage is 69%. In a generalized context we can say that TD institutions are predominantly interested in holistic problem solving approach.

Figure 29: An unbalanced picture of the “Other” areas of science



If we focus on areas of science of all institutions except SD, i.e., “Other” areas of science, the picture would look like the Figure 29 above. Only two institutions incorporate at the same time economy, ecosphere and sociosphere. Most of them 55% integrate only sociosphere and economy. Especially in the case of medicine short term solutions have been noticed most probably because **ecosystem and TD Subject were largely excluded and ignored.**

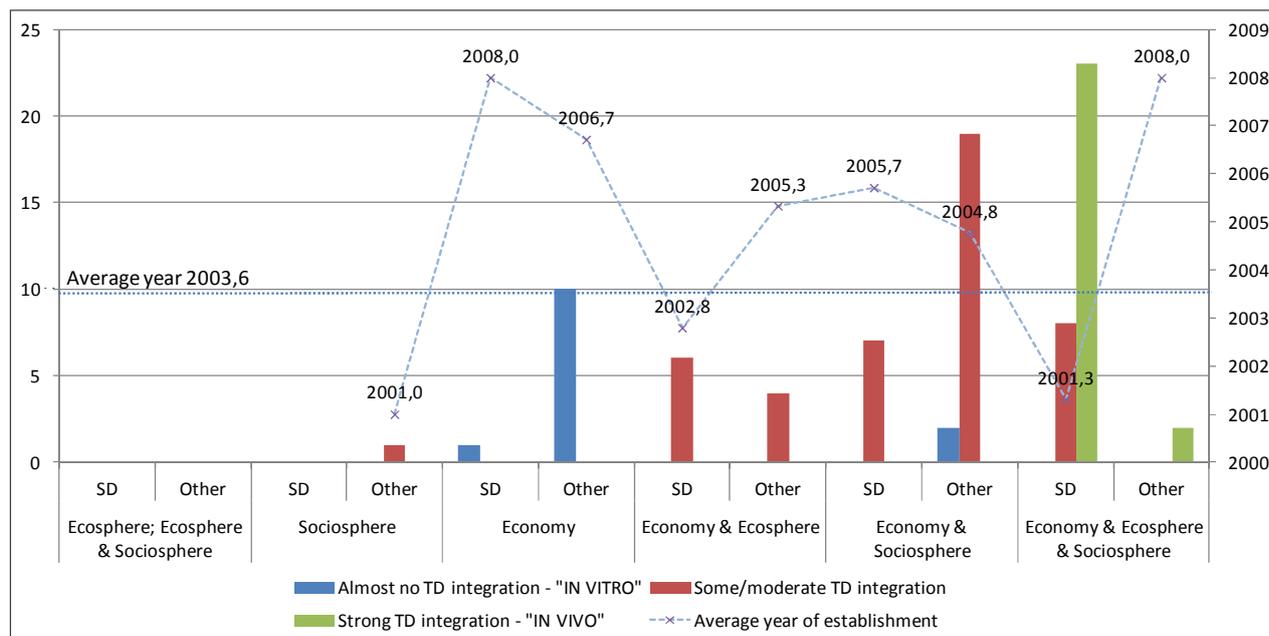
Figure 30: A balanced picture of SD area of science



There is quite big difference between the Figure 29 and the Figure 30 above. Here there are included only SD institutions and the picture looks much more harmonized. More than two-third (69%) institutions integrate economy, ecosphere and sociosphere.

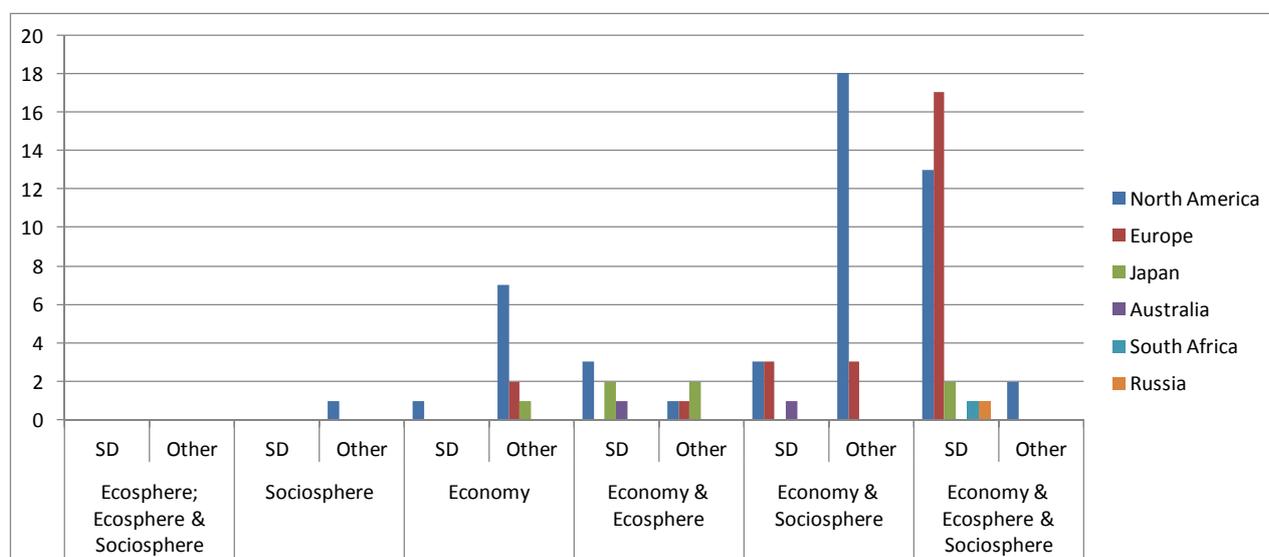
The chart below integrates four parameters, i.e., degree of TD integration, areas of SD, founding date, and primary area of science. No institutions interested in only ecosphere or simultaneously in ecosphere and sociosphere can be found.

Figure 31: Degree of TD integration, areas of SD, founding date, and primary area of science



From the relations between parameters **three main observations** can be summarized. **Firstly**, only 8% (2 institutions) of “IN VIVO” institutions are present outside the SD field, they are present in the group Medicine and biology. Again, strong or “IN VIVO” TD integration can be attributed only to institutions where economy, sociosphere and ecosphere are integrated in the unified policy. This is not a sufficient condition, but is necessary. The “IN VIVO” institutions should also include different stakeholders or systems thinking approach or complexity or Apollonian values or TD Subject, etc. **Secondly**, an institution where **economy is only area of interest** there appears only “IN VITRO” integration. **Thirdly**, on average TD institutions were established in the middle of the year **2003 and after this year only two (among 25) “IN VIVO” institutions were founded**. We can conclude that probability to find “IN VIVO” institution is higher when institution is established earlier, i.e., before the year 2003.

Figure 32: Areas of SD in relation to areas of science by location of institutions

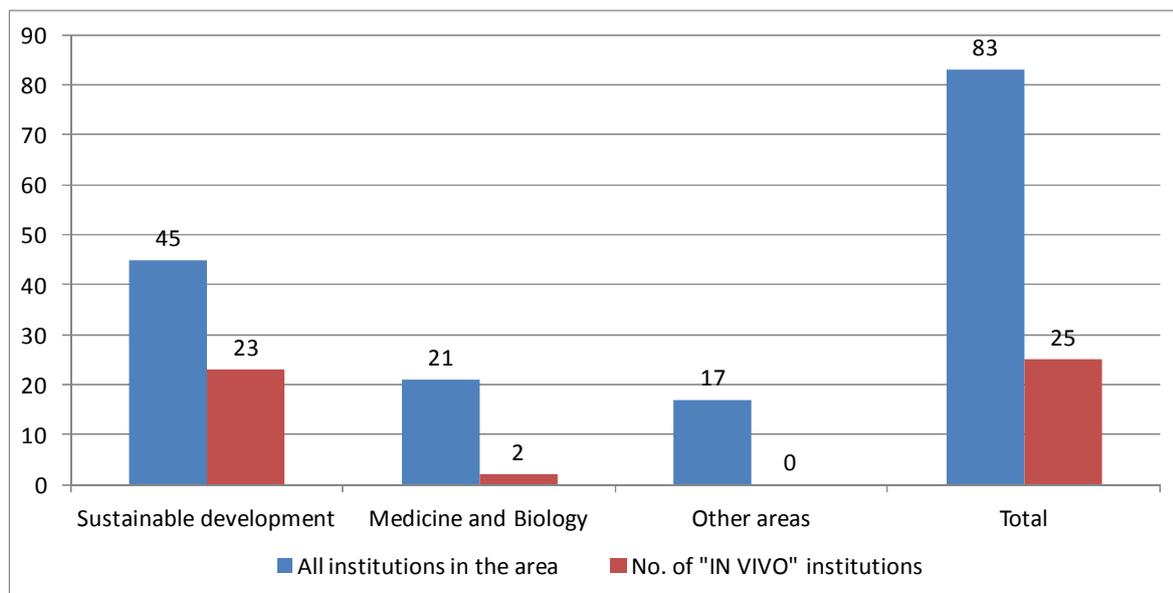


The upper graph integrates three parameters: areas of SD, location, and primary area of science. From the graph we can again see **three main findings**. **Firstly**, institutions from North America are the most active in integrating economy & sociosphere in the non-SD filed (mostly in the area of Medicine and biology), less they integrate all three SD areas together. **Secondly**, predominant occupation of all European TD institutions is SD while integrating all SD areas (17 institutions), which is 65% of all TD institutions located in Europe. In comparison with other locations, **Europe is the most successful in integrating all areas**. **Thirdly, 94% of institutions that integrate all three areas of SD are engaged with SD**, only 2 institutions are involved in other areas (see also Figure 31).

### 6.3.4 Analysis of “IN VIVO” Institutions

As I have said, the term “IN VIVO” institution refers to an institution which integrates all areas of SD and at the same time integrate different nonacademic stakeholders (civil society) and adopt systems thinking approach or/and complexity theory or/and Apollonian values or/and TD Subject, etc.

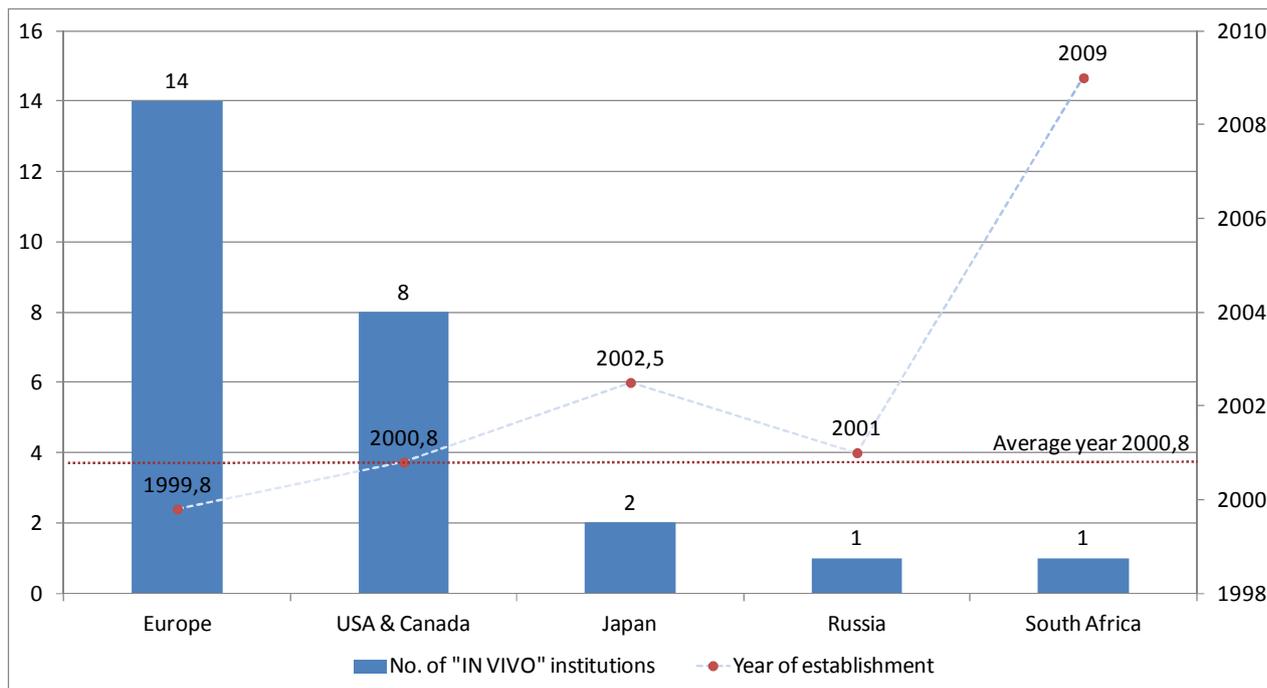
Figure 33: Number of “IN VIVO” institutions



In total there are 25 “IN VIVO” institutions (30% out of all institutions analyzed). Solely in the SD field there are 23 of them which is 92% out of all “IN VIVO” institutions, only two (8% out of all) are concerned with Medicine and biology.

Majority or 56% of all “IN VIVO” institutions are located in Europe; almost one third (32%) of them are situated in the USA and Canada. On average “IN VIVO” institutions were established at the end of the year 2000 which is approximately three years earlier than average founding date of all institutions. In general, first “IN VIVO” institutions were founded in Europe, on average in the end of the year 1999; on average one year later they were founded also in North America.

Figure 34: “IN VIVO” institutions in accordance to location and year of establishment



According to Figures 46 and 47 in appendices, most of “IN VIVO” institutions are active in research (43%) and in graduate education (32%), but much less in undergraduate education (16%). Predominant type of such institution is Research center embedded in a university (52%), following by Research center not embedded in a university (20%), Single university (16%), Multi-university network (8%) and Multi-research center network (4%) (see Appendix 11).

## 6.4 The Synthesis of the Research

In the research process relevant information and data are obtained in order to verify hypotheses. In this part of the master thesis hypotheses are confirmed or rejected. At the end of current chapter there are analyzed also other relevant findings which are more or less related to the purpose and goals of the research.

**Hypothesis 1:** Most TD institutions were recently established and there is an upward trend in the establishment of institutions.

In the last three decades there is a strong upward trend in establishing TD institutions (see Figure 39). Majority of them (51%) were established in the time period between the years 2005 and 2009. However, on average TD institutions were established in the years between 2003 and 2004; they were indeed recently established. The first institution was established in 1987 in the SD field. Among all institutions, SD institutions were on average first established, that is, in the middle of the year 2002, followed by Medicine and biology, on average in the beginning of 2004. SD institutions are therefore the pioneers of TD approach. The statement in Hypothesis 1 can be therefore easily confirmed.

**Hypothesis 2:** The main activity of TD institutions is research and much less education.

Majority of TD institutions are active in research (46%), but quite big percentage (34%) of them are also active in graduate education, i.e., masters, doctoral, and postdoctoral education. Much fewer TD institutions implement professional (certificate) programs trainings and undergraduate education (9%). First half of the Hypothesis 2 statement can be confirmed, but not the second half, since more than one third of analyzed institutions are active in graduate education. This big percentage is quite surprising, because on average TD institutions were established approximately 7 years ago.

**Hypothesis 3:** More than half of the TD institutions are located in North America, fewer in Europe and even fewer in Asia and Australia.

Most of institutions are located in the North America (57%) primarily in the USA, fewer in Europe (30%). In Asia there are 8 institutions (7 in Japan and 1 in Russia), the rest of institutions are situated in Australia (2) and South Africa (1). Based on these data we can confirm the Hypothesis 3.

Nevertheless, considering the SD group, they are located mostly in Europe (42%) and equally in North America (42%). To the greatest extent (90%) of institutions active in the group Medicine and biology are located in North America. Regarding all “IN VIVO” institutions majority or 56% of them are located in Europe; almost one third (32%) of them are situated in the USA and Canada

**Hypothesis 4:** Because TD is in nascent phase of development, institutions implement TD approach in various ways. Less than one quarter of TD institutions fully adopt and implement the concept of TD introduced in the first section of the master thesis.

Explanation for this hypothesis can be found mostly in Figure 42. The parameter “degree of TD integration” with the attribute “strong TD integration” (or “IN VIVO” integration) gives us a signal whether a certain TD institution fully adopt the concept of TD introduced in the first section of the master thesis. Other two attributes, i.e., almost no TD integration – “IN VITRO” and some/moderate TD integration, show that an institution is little or no closer to adoption of the concept of TD.

The big majorities (64%) of TD institutions carry out “some/moderate integration”, almost one-third (30%) implement “strong TD integration”, and minorities (19%) are much away from the concept of TD (“almost no TD integration”). It is evident that TD institutions really implement TD approach in different ways, thus we can confirm first part of Hypothesis 4. But the second part of this hypothesis can be rejected, since 30% (more than 25% – one quarter) of all institutions analyzed fully adopt the concept of TD (see Figure 33). This conclusion is quite surprising because TD is in early or nascent phase of development.

**Hypothesis 5:** A strong correlation between SD institutions with the concept of TD exists. Institutions directly related to SD predominantly use a holistic TD approach that integrates economy, ecosphere, and sociosphere. In such institutions the concept of TD is the most consistently applied, unlike in other institutions that are indirectly related to SD.

To verify this hypothesis we need to analyze Figure 33. In total there are 25 “IN VIVO” institutions (30% out of all). Solely in the SD field there are 23 of them which is 92% out of all “IN VIVO” institutions. Other two “IN VIVO” institutions are present in the “Medicine and biology” area of science. According to Table 19 (Appendix 10) biggest proportion (51%) of “IN VIVO” institutions is present in SD group, less (10%) in the “Medicine and biology”, in other groups there are no “IN VIVO” institutions.

Also Figure 28 can help us to further verify Hypothesis 5. Only in the SD field there are situated 94% of all TD institutions (from all areas of science) that integrate all three SD areas (economy, ecosphere and sociosphere). Proportion of such institutions in the SD group is also very high (69%). On the basis of these analyses we can fully confirm Hypothesis 5.

**Other meaningful findings.** The probability to find “IN VIVO” institution is higher when an institution is established earlier (before the year 2000), when it is located in Europe, is active in the field of SD, its type is “Research center embedded in a university”, and is active in research or graduate education. On the other side, the greatest probability (100%) to find an “IN VITRO” institution is when economy is the only area considered from among all areas of SD.

On average “IN VIVO” institutions were established at the end of the year 2000 which is approximately three years earlier than all institutions on average. It is evident that institutions founded in the recent times (in the last 8 years) lose their comprehensive view of the concept of TD. The reason could be in **abusing TD for commercial – marketing purposes.**

In North America there are located in total more analyzed TD institutions (23) than in Europe. Nevertheless, on average first “IN VIVO” institutions were established in Europe (end of the year 1999), on average one year later they were founded in the North America. Although both continents have the same number of SD institutions (20 institutions) there are in Europe situated 56% of all “IN VIVO” institutions (in North America only 32%). In general, North America’s institutions are the most active in integrating economy & sociosphere in the non-SD groups (mostly in the group Medicine and biology); less they integrate all of three SD areas. It can be argued that **Europe is the most successful in adopting and implementing the concept of TD.**

## CONCLUSION

The global world is becoming increasingly more connected, but at the same time the global problems are becoming much too complex to be successfully solved within a single discipline. Such problems are complex systems (system-of-systems) problems that require translation between different “vocabularies”. New ways of thinking are needed in order to unite traditional disciplines beyond the classical notion of science (traditional boundaries) and to fill the

knowledge gaps. Among others, also economics can significantly contribute to the development of effective conservation solutions applicable to SD by exploring complementary approaches focused on the complex, emergent, dynamic interactions amongst disciplines. This process will surely require the development of the “TD bridges”.

TD is a new way of thinking and understanding of complex systems problems since it crosses borders of separated disciplines. Holistic and unified knowledge, which focus is rather positive than normative, can cope with complex global SD problems. On the other side, the reductionistic or DK unbalances SD and causes a downturn spiral to much deeper global problems. For example, in multidisciplinary research, disciplinary researchers implement analyses of a given problem by adding up the results with very little communication or low mutual understanding.

In case of interdisciplinary research, there is more communication and collaboration, but the basic approach is to divide a problem into separate components to which each disciplinary expert applies disciplinary methodology, regardless of the problem. It does not solve incompatibilities between disciplines in the quest for knowledge unification. In contrast, TD researchers assess many views of a problem in an integrated way. However, integration is much more difficult and much more time consuming than addition or division of DK.

The main objective of TD is to understand the present world by including interactions between knowledge and being and between TD Subject and TD Object. By introducing unity of knowledge, we can develop new TK and unified SD strategy. TD offers an innovative working environment appropriate for finding evolving systems solutions to complex developmental problems. It fosters new relationships among traditionally independent disciplines.

Disciplinary research concerns only one level of Reality, but TD extends its activities through several levels of Reality. Disciplinarity and TD are not in conflict; instead, they are complementary and together generate reciprocal enrichment. TD does not call for the dissolution of borders between disciplines, but for formation of new synergy, new knowledge. Knowledge generated within disciplines is moved beyond the disciplinary boundaries to make new connections between academia and also between civil societies. TD is not (and also does not create) a new discipline or super-discipline, it is rather a different way of seeing the world, more systemic and more holistic.

The TD approach is much different from conventional dichotomized disciplinary approaches that avoid crossing disciplinary boundaries and are even less prepared for collaboration with civil societies. The Evolving, emergent and complex nature of TK requires lifelong learning that aims to empower everyone to make sustainable decisions and act according to Apollonian values.

TD gives better understanding of SD systems nature, principles and models. With the TD integrative collaboration, we can depict problems from a holistic point of view. Viewing these problems through an economic lens alone will not lead to solutions. As Albert Einstein said: “We cannot solve problems by using the same kind of thinking we used when we created them”. As well as other disciplines also economics has been increasingly narrowly defined, but

nevertheless, the economic lens can be incorporated into a more holistic understanding of the problem, and could contribute to SD potential solutions. TD systems approach to SD is needed, in terms of projecting multiple lenses into a coherent picture.

Social, cultural, and economic (qualitative as well as quantitative) changes are needed. There are many insights for current SD management to be learned, e.g., the science of complexity, systems thinking, quantum logic (as a substitute for linear logic), axiology, chaos theory, living systems theory, contemporary philosophy, consciousness sciences, and other natural and human sciences; nowadays corporate management has no idea how to develop processes for managing the complex real-world problems of sustainable policy and management. Transformation does not mean just a change in worldviews and habits of thinking, but is also a change in people's experiences and their overall being in the world.

Essentially, the ethical dimension is a core of SD (and also TD) and without this dimension SD is similar to fiction or selfish manipulation. Ethics, related to SD, encompasses at least three aspects: the moral relationship between humans and other currently living humans, future generations of humans, and non-human nature. There are not many people who deal with ethics (as philosophical discipline) in our society, because such a profile is unemployable. In current society, there are no such positions of employment, since the ethical dimension is not in the interests of neoliberal capitalism. Therefore, in our society, SD is like fiction. Management should encourage changes in moral sensitivities, attitudes and behaviors/lifestyles of workers and consumers, but unfortunately the current socioeconomic system does not reward such attitudes. It is clear that TD changes are emerging and evolving and only by encouraging TD learning the changes in the long run are possible. The TD approach can help SD to empower people to recognize, accept and respect the four pillars of methodology of TD including multiple levels of Reality, the logic of the included middle (TD Subject & TD Object, flow of consciousness & information, the Hidden Third, etc.), complexity and axiology.

Not only management, but also education for SD should be re-envisioned in terms of necessities of working at the interface of different (sometimes contradictory) disciplines. Natural sciences provide important knowledge of ecological processes, but they do not contribute to human values and attitudes (humanities and social sciences) which are also the basic elements of SD. An integrated synthesis is not achieved through the simple accumulation of different views. It must occur inside of each person's mind and thus, we need to orient higher education in a way that respects the role of TD Subject, and consequently, the probability for achieving SD purposes would be much higher.

Uni-disciplinary education and research are still widely predominant in all institutions around the world. Nevertheless, during the research process outstanding institutions were found that adopt the TD approach rather than the classical linear logic. The summary of the research results is already presented in Chapter 6.4 and Appendices 7–10.

Weak TD, i.e., almost no TD integration, is the simplest and quickest way of SD problem solving. It helps, but it is far from being sufficient. Strong TD (“IN VIVO”) integration, on the

other hand, is both a tool and a project. An evolving project which demands many creative efforts of people from different areas of interests (economy, sociosphere and ecosphere) who integrate also different nonacademic stakeholders (civil society) and approaches, such as systems thinking approach, complexity theory, Apollonian values, etc. SD needs to release the tension between different areas of interest and develop a common concept to the same level of Reality. To do that, there is a long way of solving contradictions; but this could only be achieved through changing of levels of perception of people in different disciplines in order to pursue a common goal. **Different areas of interest cannot have the same content, but they can share the same meaning.** However, the fundamental SD question is “how to change levels of perception of people being employed in disciplines with contradictory concepts to pursue a common goal?” The answer offered by the TD approach is: by the flow of consciousness/information and by the “operating” shared zone of non-resistance. But is society ready for such a visionary transformation? Sooner or later it has to be.

In the general context of our world we are witnessing economical globalization, but at the same time fragmentation of knowledge. It seems that the world is opened only to economic globalization and generalization of “the American way of living” which corresponds to the motto “Work, consume and be silent”. Borrowing from future generations and the inability of finding the international visionary agreement in the context of SD, there is no reliable answer to the question: “How can we in modern societies achieve morally and ethically proper functioning of influential elites?” It is impossible that growth-oriented wealthy elite can contribute to solutions with any changes in legal system, while capitalism brings them a lot of materialistic benefits. Because of their blindness, they cannot see common meaningful goal; they use their illegitimate power only for reductionist (egoistic, destructive) purposes. Moreover, also custodians of public morality, i.e., religious institutions, are not resistant to the abuse of power and many times do not encourage people to grow in terms of Apollonian values. Responsibility for SD is left to isolated individuals who are powerless to change socioeconomic environments towards SD.

## LITERATURE AND SOURCES

1. *Aalborg University Copenhagen*. Retrieved October 1, 2011, from <http://en.cph.aau.dk/>
2. Ackoff. (n.d.) In *Wikipedia*. Retrieved May 30, 2011, from [http://en.wikipedia.org/wiki/Russell\\_L.\\_Ackoff](http://en.wikipedia.org/wiki/Russell_L._Ackoff)
3. Aristotle. (1984). *Politics. The Complete Works of Aristotle: The Revised Oxford Translation*. Princeton: Princeton University Press.
4. Arthur, W. (1989). Competing technologies, increasing returns, and lock-in by historical events. *The Economic Journal*, 99, 116–31.
5. Ashby, W. R. (1973). Some peculiarities of complex systems. *Cybernetic Medicine*, 9(2), 1–6.
6. *ATLAS*. Retrieved October 29, 2011, from [http://www.theatlas.org/index.php?option=com\\_content&view=article&id=14&Itemid=29](http://www.theatlas.org/index.php?option=com_content&view=article&id=14&Itemid=29)
7. Bailey, K.D. (1994). *Sociology and the New Systems Theory: Toward a Theoretical Synthesis*. New York: State of New York Press.
8. Barkley Rosser Jr., J. (2010). Is a transdisciplinary perspective on economic complexity possible? *Journal of Economic Behavior & Organization (Elsevier B.V.)*, 75, 3–11.
9. Baumgärtner, S., Becker, C., Frank, K., Müller, B., Quaas, M. (2008). Relating the philosophy and practice of ecological economics: the role of concepts, models, and case studies in inter- and transdisciplinary sustainability research. *Ecological economics (Elsevier B.V.)*, 67, 384–393.
10. Baumgärtner, S., Quaas, M. (2010). What is sustainability economics? *Ecological Economics (Elsevier B.V.)*, 69, 445–450.
11. Becher, T. (1989). *Academic Tribes and Territories – Intellectual Enquiry and the Cultures of Disciplines. The Society for Research into Higher Education*. Milton Keynes: Stony Stratford.
12. Becker, C. (2009). *Sustainability Ethics and Sustainability Research (Habilitation Thesis)*. Kaiserslautern: Technical University of Kaiserslautern.
13. Becker, G. S. (1978). *The Economic Approach to Human Behavior*. Chicago: University of Chicago Press.
14. Benyus, J. (2002). *Innovation Inspired by Nature*. New York: Harper Collins Publishers Inc.
15. Bergeå, O., Karlsson, R., Hedlund-Åström, A., Jacobsson, P., & Luttrupp, C. (2006). Education for sustainability as a transformative learning process: a pedagogical experiment in EcoDesign doctoral education. *Journal of Cleaner Production (Elsevier Ltd)*, 14, 1431–1442.
16. Berkes, F., & Folke, C. (1998). *Linking social and ecological systems: management practices and social mechanisms for building resilience*. Cambridge: Cambridge University Press.
17. Biomimicry. (n.d.) In *Wikipedia*. Retrieved June 4, 2011, from <http://en.wikipedia.org/wiki/Biomimicry>
18. Borins, S., & Brown, L. (1986). *Investment in Failure*. Ontario: Methven, Agincourt.
19. Boulding, K. E. (1956). General systems theory – the skeleton of science. *Management Science*, 2, 197–208.

20. Boxfish. (n.d.) In *Wikipedia*. Retrieved June 23, 2011, from [http://en.wikipedia.org/wiki/Yellow\\_boxfish](http://en.wikipedia.org/wiki/Yellow_boxfish)
21. Brody, T.A. (1984). On Quantum Logic. *Foundation of Physics*, 14(5), 409–430.
22. Buckley, W. (1967). *Sociology and Modern Systems Theory*. New Jersey: Englewood Cliffs.
23. Capitalism. (n.d.) In *Wikipedia*. Retrieved May 25, 2011, from <http://en.wikipedia.org/wiki/Capitalism>
24. Capra, F. (1982). *The Turning Point*. London: Fontana.
25. Capra, F. (1996). *The web of life: a new scientific understanding of living systems*. New York: Anchor Books.
26. Charles Robert Darwin. (n.d.) In *Wikipedia*. Retrieved May 14, 2011, from [http://en.wikipedia.org/wiki/Charles\\_Darwin](http://en.wikipedia.org/wiki/Charles_Darwin)
27. Chen, P. (2002). Microfoundations of macroeconomic fluctuations and the laws of probability theory: the principle of large numbers versus rational expectations arbitrage. *Journal of Economic Behavior and Organization*, 49, 327– 344.
28. CIRET – International Center for Transdisciplinary Research. Retrieved May 23, 2011, from <http://basarab.nicolescu.perso.sfr.fr/ciret/indexen.html>
29. Clark, T. W. (2002). *The Policy Process: A Practical Guide for Natural Resource Professionals*. New Haven: Yale University Press.
30. Cole, A. (2006). *Transdisciplinarity, a local sustainability problématique and the Achilles-heel of Western science*. Motueka: Catchment futures.
31. Complex adaptive systems. (n.d.) In *Wikipedia*. Retrieved February 23, 2011, from [http://en.wikipedia.org/wiki/Complex\\_adaptive\\_system](http://en.wikipedia.org/wiki/Complex_adaptive_system)
32. Consilience. (n.d.) In *Wikipedia*. Retrieved June 27, 2011, from <http://en.wikipedia.org/wiki/Consilience>
33. Costanza, R. (1989). What is ecological economics? *Ecological Economics*, (1), 1–7.
34. Costanza, R. (2001). Visions, values, valuation, and the need for an ecological economics. *Bioscience*, 51(6), 459– 468.
35. Costanza, R. (2006). Toward an Ecological Economy. *The Futurist*, 40(4), 26.
36. Daellenbach, H. G., & McNickle, D. C. (2005). *Management science Decision making through systems thinking*. Hampshire: Palgrave Macmillan.
37. Daly, H. E. (1999). *Uneconomic growth in theory and in fact*. Dublin: Trinity College.
38. Daly, H. E., & Farley, J. (2004). *Ecological economics: principles and applications*. Washington, DC: Island Press.
39. Daly, H. E. (2005). Economics in a Full World. *Scientific American*, 293(3).
40. Deconstructionism. In *The Free Dictionary by Farlex*. Retrieved June 29, 2011, from <http://www.thefreedictionary.com/deconstructionism>
41. DesJardins, J. (2005). *Environmental Ethics* (4<sup>th</sup> ed.). London: Wadsworth.
42. Dissipative system. (n.d.) In *Wikipedia*. Retrieved July 3, 2011, from [http://en.wikipedia.org/wiki/Dissipative\\_system](http://en.wikipedia.org/wiki/Dissipative_system)
43. Doctrine of satkaryavada. (n.d.) In *Wikipedia*. Retrieved May 26, 2011, from <http://en.wikipedia.org/wiki/Causality>
44. Duchin, F. (1998). *Structural Economics*. Washington, DC: Island Press.

45. *Ecological Economics Journal*. Retrieved May 16, 2011, from [http://www.elsevier.com/wps/find/journaldescription.cws\\_home/503305/description#description](http://www.elsevier.com/wps/find/journaldescription.cws_home/503305/description#description)
46. Edgar. (n.d.) In *Wikipedia*. Retrieved May 16, 2011, from [http://en.wikipedia.org/wiki/Edgar\\_Morin](http://en.wikipedia.org/wiki/Edgar_Morin)
47. Environmental economics. (n.d.) In *Wikipedia*. Retrieved June 13, 2011, from [http://en.wikipedia.org/wiki/Environmental\\_economics#cite\\_note-0](http://en.wikipedia.org/wiki/Environmental_economics#cite_note-0)
48. Faber, M., Manstetten, R., & Proops, J. (1992). Toward an open future: ignorance, novelty, and evolution. In Costanza, R., Norton, B., and Haskell, B., *Ecosystem Health: New Goals for Environmental Management* (pp. 72–96). Washington DC: Island Press.
49. Faber, M. (2008). How to be an ecological economist. *Ecological Economics*, 66(1), 1–7.
50. Farley, J. (2010). Conservation Through the Economics Lens. *Environmental Management (Springer Science+Business Media, LLC)*, 45, 26–38.
51. Feedback loop. In *Online Business Dictionary*. Retrieved May 25, 2011, from <http://www.businessdictionary.com/definition/feedback-loop.html>
52. Forstater, M. (2004). Visions and scenarios: Heilbroner's worldly philosophy, Lowe's political economics, and the methodology of ecological economics. *Ecological Economics (Elsevier B.V.)*, 51, 17–30.
53. Funtowicz, S.O., & Ravetz, J.R., (1994). The worth of a songbird: ecological economics as a postnormal science. *Ecological Economics*, 10, 197–207.
54. Georgescu-Roegen, N. (1971). *The Entropy Law and the Economic Process*. Cambridge: Harvard University Press.
55. Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The New Production of Knowledge*. London: Sage.
56. Gleick, J. (1987). *Chaos, Making a New Science*. London: Penguin Books.
57. Guston, D. H., & Sarewitz, D. (2002). Real-time technology assessment. *Technology in Society*, 24, 93–109.
58. Hadorn, G., Bradley, D., Pohl, C., Rist, S., & Wiesmann, U. (2006). Implications of Transdisciplinarity for sustainability research. *Ecological Economics*, 60, 119–128.
59. Hammer, M., & Söderqvist, T. (2001). Enhancing transdisciplinary dialogue in curricula Development. *Ecological Economics (Elsevier Science B.V.)*, 38, 1–5.
60. Hammond, D. (2003). *The Science of Synthesis*. Colorado: University of Colorado Press.
61. Haugaard Jakobsena, C., Hels, T., & William, J. (2004). Barriers and facilitators to integration among scientists in transdisciplinary landscape analyses: a cross-country comparison. *Forest Policy and Economics, Elsevier Science B.V.*, 6, 15–31.
62. Hausman, D. M., & McPherson, M. S. (2006). *Economic Analysis, Moral Philosophy and Public Policy* (2<sup>nd</sup> ed.). Cambridge: Cambridge University Press.
63. Heilbroner, R. (1970). *Ecological Armageddon. Between Capitalism and Socialism*. New York: Random House.
64. Heisenberg, W. (1952). *The teachings of Goethe and Newton on colour in the light of modern physics. Philosophical Problems of Nuclear Science*. London: Faber and Faber.
65. Heisenberg, W. (1998). *Philosophie – Le manuscrit de 1942* (translation from German and introduction by Catherine Chevalley). Paris: Seuil.

66. Hirsch Hadorn, G., et al. (2008). *Handbook of Transdisciplinary Research*. Zurich: Springer Science & Business Media B.V.
67. Hodgson, G. (1988), *Economics and Institutions*. Cambridge: Polity Press.
68. Hull, D. L. (1970). Systemic Dynamic Social Theory. *Sociological Quarterly*, 11(3), 351–363.
69. Husserl, E. (1966). *Méditations cartésiennes, translated form German by Gabrielle Peiffer and Emmanuel Levinas*. Paris: Vrin.
70. In Vitro. (n.d.) In *Wikipedia*. Retrieved September 16, 2011, from [http://en.wikipedia.org/wiki/In\\_vitro](http://en.wikipedia.org/wiki/In_vitro)
71. *The Institute for Social-Ecological Research*. Retrieved November 6, 2011, from <http://www.isoe.de/english/research.htm>
72. Jasanoff, S. E. (2004). *States of Knowledge: The Co-production of Science and Social Order*. London: Routledge.
73. Kajikawa, Y., Ohno, J., Takeda, Y., Matsushima K., & Komiyama, H. (2007). Creating an academic landscape of sustainability science: an analysis of the citation network. *Sustainability Science (Springer)*, 2, 221–231.
74. Kenny, S. (1994). *Developing Communities for the Future: Community Development in Australia*. Australia: Thomas Nelson.
75. Klein, J. T., Grossenbacher-Mansuy, W., Häberli, R., Bill, A., Scholz, R. W., & Welti, M. (2001). *Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society, in Synthesebücher, Swiss Priority Programme Environment*. Basel: Birkhäuser.
76. Kurt Gödel. (n.d.) In *Wikipedia*. Retrieved October 8, 2011, from [http://en.wikipedia.org/wiki/Kurt\\_G%C3%B6del](http://en.wikipedia.org/wiki/Kurt_G%C3%B6del)
77. Laszlo, E. (1972a). *Introduction to systems philosophy. Toward a new paradigm of contemporary thought*. San Francisco: Harper.
78. Laszlo, E. (1972b), *The Systems View of the World*. New York: G. Braziller.
79. Laszlo, E. (2003). *The consciousness revolution*. USA: Elf Rock Productions.
80. Lattanzi, M. (1998). Transdisciplinarity at UNESCO. Retrieved February 5, 2011, from <http://unesdoc.unesco.org/images/0011/001146/114694eo.pdf>
81. Lawn, P. A. (2001). *Toward Sustainable Development*. Florida, Boca Raton: Lewis Publishers.
82. Lawn, P. A. (2006). *Sustainable development indicators in ecological economics*. USA: Edward Elgar Publishing Limited.
83. Lawrence, R. J., & Despre's, C. (2004). Futures of Transdisciplinarity. *Futures*, 36, 398.
84. Leibniz. (n.d.) In *Wikipedia*. Retrieved February 26, 2012, from [http://en.wikipedia.org/wiki/Gottfried\\_Leibniz](http://en.wikipedia.org/wiki/Gottfried_Leibniz)
85. *Linear logic*. Retrieved May 9, 2011, from <http://plato.stanford.edu/entries/logic-linear/>
86. Lowe, A. (1977). *On Economic Knowledge*. New York, Armonk: M.E. Sharpe. Enlarged Edition.
87. Lupasco, S. (1987). *Le principe d'antagonisme et la logique de l'énergie* (2<sup>nd</sup> ed.). Paris: Le Rocher.
88. *MacArthur*. Retrieved July 26, 2011, from [http://www.macfound.org/site/c.lkLXJ8MQKrH/b.855245/k.588/About\\_the\\_Foundation.htm](http://www.macfound.org/site/c.lkLXJ8MQKrH/b.855245/k.588/About_the_Foundation.htm)

89. Madni A. M. (2007). Transdisciplinarity: reaching beyond disciplines to find connections. *Society for Design and Process Science*, 11(1), 1–11.
90. Mäki, U. (2002). *Fact and Fiction in Economics. Models, Realism and Social Construction*. Cambridge: University Press.
91. Mallmann, C., Max-Neef, M., & Aguirre, R. (1979). *La sinergia humana como fundamento etico y estetico del desarrollo*. In *Investigación y Necesidades Humanas*, Montevideo, Uruguay: Centro Latinoamericano de Economía Humana.
92. Max-Neef, M. A. (2005). Foundations of Transdisciplinarity. *Ecological Economics (Elsevier B.V.)*, 53, 5–16.
93. Mayer, E. (1997). *This is Biology. The Science of the Living World*. Cambridge, Massachusetts: Harvard University Press.
94. McGregor, S. L. T. (2011, March). Demystifying Transdisciplinary Ontology: Multiple Levels of Reality and the Hidden Third. *Integral Leadership Review*. Retrieved October 9, 2011, from <http://integralleadershipreview.com/1746-demystifying-transdisciplinary-ontology-multiple-levels-of-reality-and-the-hidden-third>
95. McGregor, S. L. T. (2007). Consumer scholarship and transdisciplinarity. *International Journal of Consumer Studies*, 31(5), 487–495.
96. *MDP - The Global Master's in Development Practice*. Retrieved July 19, 2011, from <http://globalmdp.org/>
97. Meadows, D. (1996). Envisioning a sustainable world. In Costanza, R., Segura, O., Martinez-Alier, J., *Getting Down to Earth*. Washington, DC: Island Press.
98. Meppem Roderic Gill, T. (1998). Planning for sustainability as a learning concept. *Ecological Economics (Elsevier Science B.V.)*, 26, 121–137.
99. Mittelstrass, J. (1993). Unity and Transdisciplinarity. *Interdisciplinary Science Review*, 18, 153–157.
100. Morin, E. (1986). *La méthode III – La connaissance de la connaissance/1. Anthropologie de la connaissance*. Paris: Seuil.
101. Muhar, A., et al. (2006). Initiating transdisciplinarity in academic case study teaching Experiences from a regional development project in Salzburg. *Austria International Journal of Sustainability in Higher Education. Emerald Group Publishing Limited*, 7(3), 293–308.
102. Mulder, P., & van den Bergh, J. (2001). Evolutionary economic theories of sustainable development. *Growth and Change*, 32, 110–34.
103. Musek, J. (1986). Basic categories and dimensions of values and value-systems. *Anthropos*, 16(1–2), 49–57.
104. Musek, J. (1993a). Implicit values categories and dimensions: Hierarchical structure of values and values orientations. *Anthropos*, 25(1–2), 31–51.
105. Musek, J. (1993b). *Personality and values*. Ljubljana: Educy.
106. Musek, J. (1993c). Spiritual crisis, values and psychology. *Psihološka obzorja*, 2(3–4), 123–141.
107. Musek, J. (1994). *Values and value orientations in the background of European cultural traditions*. Ljubljana: Anthropos, International Issue.
108. Musek, J. (2000). *Nova psihološka teorija vrednot [The new psychological theory of values]*. Ljubljana: Educy.

109. The Natural Law Tradition in Ethics. In *Stanford encyclopedia of philosophy*. Retrieved March 11, 2011, from <http://plato.stanford.edu/entries/natural-law-ethics/>
110. Nature Neuroscience. *Editorial*, 3(2), p. 97. Retrieved March 18, 2011, from <http://www.nature.com/neuro/>
111. Naydler, J. (2000). *Goethe on Science*. Great Britain: Floris Books.
112. *Network for Transdisciplinary Research*. Retrieved October 5, 2011, from <http://www.transdisciplinarity.ch/e/About/>
113. Nicolescu, B. (1998). *Goedelian aspects of nature and knowledge*. Bulletin Interactif du Centre International de Recherches et Etudes Transdisciplinaires. Paris: International Center for Transdisciplinary Research – CIRET.
114. Nicolescu, B. (1999). *Stephane Lupesco, L'homme et l'oeuvre*. Paris: La Rochet.
115. Nicolescu, B. (2002). *Manifesto of Transdisciplinarity*. New York: SUNY Press.
116. Nicolescu, B. (2005). *Towards Transdisciplinary Education and Learning*. Paper prepared for “Science and Religion: Global Perspectives”, a program of the Metanexus Institute. Philadelphia: Metanexus Institute.
117. Nicolescu, B. (2010). *Disciplinary boundaries – What are they and how they can be transgressed?* Paper Prepared for the International Symposium on Research Across Boundaries. Luxembourg: University of Luxembourg.
118. Nissani, M. (1997). Ten cheers for interdisciplinarity. *Social Science Journal*, 34(2), 201–216.
119. Nonlinear system. (n.d.) In *Wikipedia*. Retrieved May 25, 2011, from [http://en.wikipedia.org/wiki/Nonlinear\\_system](http://en.wikipedia.org/wiki/Nonlinear_system)
120. Norgaard, R. (1985). Environmental economics: an evolutionary critique and a plea for pluralism. *Journal of Environmental Economics and Management*, 12, 382–94.
121. Norgaard, R. (1994). *Development Betrayed: The End of Progress and a Coevolutionary Revisioning of the Future*. London: Routledge.
122. Norton, B. (2005). *Sustainability: a philosophy of adaptive ecosystem management*. Chicago: University of Chicago Press.
123. Piaget, J. (1972). *L'épistémologie des relations interdisciplinaires, in L'interdisciplinarité – Problèmes d'enseignement et de recherche dans les universités*. Paris: OECD – The Organisation for Economic Co-operation and Development.
124. Pohl, C. (2005). Transdisciplinary collaboration in environmental research. *Futures, Elsevier Ltd.*, 37, 1159–1178.
125. Polimeni, J. M. (2004). Graduate education in ecological economics. *Ecological Economics (Elsevier B.V.)*, 51, 287–293.
126. Polya, G. (1957). *How to Solve It*. Princeton: Princeton University Press.
127. Proops, J. (1989). Ecological economics: rationale and problem areas. *Ecological Economics*, 1, 59–76.
128. Prugh, T., Costanza, R., & Daly, H. E. (2000). *The Local Politics of Global Sustainability*. Washington, DC: Island Press.
129. Rayner, S., & Malone, E. L. (1998). The Challenge of Climate Change to the Social Sciences. *Human Choice and Climate Change*, 4, 37.
130. Rede Lecture. (n.d.) In *Wikipedia*. Retrieved November 21, 2011, from [http://en.wikipedia.org/wiki/Rede\\_Lecture](http://en.wikipedia.org/wiki/Rede_Lecture)

131. Reductionism. (n.d.) In *Wikipedia*. Retrieved May 14, 2011, from [http://en.wikipedia.org/wiki/Reductionism#cite\\_note-0](http://en.wikipedia.org/wiki/Reductionism#cite_note-0)
132. *Resource economics*. Retrieved June 21, 2011, from <http://cels.uri.edu/enre/>
133. Richardson, K. (2004). General systems theory – the skeleton of science. *E:CO Special Double Issue*, 6(1–2), 127–139.
134. Rodriguez Delgado. (n.d.) In *Wikipedia*. Retrieved November 1, 2011, from [http://en.wikipedia.org/wiki/Jos%C3%A9\\_Manuel\\_Rodríguez\\_Delgado](http://en.wikipedia.org/wiki/Jos%C3%A9_Manuel_Rodríguez_Delgado)
135. Røpke, I. (2005). Trends in the development of ecological economics from the late 1980s to the early 2000s. *Ecological Economics*, 55, 262–290.
136. Rotering, F. Retrieved October 4, 2011, from <http://needsandlimits.org>
137. Schein, E. H. (1980). *Organizational Psychology* (3<sup>rd</sup> ed.). New Jersey: Prentice-Hall.
138. Schneider, B. (2003). Knowledge beyond disciplines. *The Flame – Claremont Graduate University Magazine*, 4(3), 12–17.
139. Self-organization. (n.d.) In *Wikipedia*. Retrieved July 22, 2011, from <http://en.wikipedia.org/wiki/Self-organization>
140. Senge, P. (2000). *Schools That Learn: A Fifth Discipline Fieldbook for Educators, Parents, and Everyone Who Cares About Education*. New York: Doubleday Dell Publishing Group.
141. Shaw A., & Kim J. (2008). *Report from the International Commission on Education for Sustainable Development Practice*. New York: The Earth Institute at Columbia University New York, Brooklyn.
142. SIPA - School of International and Public Affairs at Columbia University. Retrieved July 16, 2011, from [http://www.sipa.columbia.edu/about\\_sipa/index.html](http://www.sipa.columbia.edu/about_sipa/index.html)
143. Skyttner, L. (2006). *General Systems Theory: Problems, Perspective, Practice*. Singapore: World Scientific Publishing Company.
144. Snow, C. P. (1964). *The Two Cultures and a Second Look-An Expanded Version of the Two Cultures and the Scientific Revolution* (2<sup>nd</sup> ed.). Cambridge: University Press.
145. Snow. (n.d.) In *Wikipedia*. Retrieved July 1, 2011, from [http://en.wikipedia.org/wiki/C.\\_P.\\_Snow](http://en.wikipedia.org/wiki/C._P._Snow)
146. Somerville, M. A., & Rapport, D.J. (2003). *Transdisciplinarity – Recreating Integrated Knowledge*. Montreal: McGill-Queens University Press.
147. Stiglitz, J. E. (2006). *Making Globalization Work*. New York: W.W. Norton & Company.
148. Systems philosophy. (n.d.) In *Wikipedia*. Retrieved May 7, 2011, from [http://en.wikipedia.org/wiki/Systems\\_philosophy](http://en.wikipedia.org/wiki/Systems_philosophy)
149. Systems theory. (n.d.) In *Wikipedia*. Retrieved May 12, 2011, from [http://en.wikipedia.org/wiki/Systems\\_theory](http://en.wikipedia.org/wiki/Systems_theory)
150. Systems thinking. (n.d.) In *Wikipedia*. Retrieved May 19, 2011, from [http://en.wikipedia.org/wiki/Systems\\_thinking#cite\\_note-2](http://en.wikipedia.org/wiki/Systems_thinking#cite_note-2)
151. Tilbury, D. (2010). *Assessing ESD Experiences during the DESD*. An expert review on processes of learning for ESD. Paris: UNESCO.
152. UNESCO. Retrieved October 28, 2011, from <http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/education-for-sustainable-development/>
153. UNESCO. (1997). *UNESCO Educating for a Sustainable Future: A Transdisciplinary Vision for Concerted Action*. Paris: UNESCO.

154. UNESCO. (2002). *UNESCO Education for Sustainability: from Rio to Johannesburg: Lessons Learnt from a Decade of Commitment*. Paris: UNESCO.
155. *UNESCO ESD*. Retrieved July 6, 2011, from [http://portal.unesco.org/education/en/file\\_download.php/bbf62dcbe22c3c1c1742131c079419cebrief+TD+Nature+of+ESD.pdf](http://portal.unesco.org/education/en/file_download.php/bbf62dcbe22c3c1c1742131c079419cebrief+TD+Nature+of+ESD.pdf)
156. United Nations. (1971). Report of the 1969 Meeting of Experts on Social Policy and Planning. *International Social Development Review*, 3.
157. *University of Cambridge*. Retrieved October 7, 2011, from <http://www.cpsl.cam.ac.uk/Resources/Publications-and-Downloads/Publications-library.aspx>
158. van Breda, J. (2008). Exploring non-reductionism and levels of Reality. *The Global Spiral*, 9(4).
159. Voinov A. (2008). *Systems Science and Modeling for Ecological Economics*. London: Elsevier Inc.
160. *Waters foundation*. Retrieved May 5, 2011, from <http://www.watersfoundation.org/index.cfm?fuseaction=materials.main>
161. WCED – World Commission on Environment and Development. (1987). *Our Common Future*. New York: Oxford University Press.
162. *Web of Knowledge*. Retrieved March 10, 2011, from <http://wokinfo.com/>
163. *Webometrics*. Retrieved August 29, 2011, from <http://www.webometrics.info/>
164. Wheeler, K. A., & Bijur, A.P. (2001). *Education for a Sustainable Future: a Paradigm of Hope for the 21 Century*. New York: Kluwer Academic.
165. Wickson, F., Carew, A. L, & Russell, A. W. (2006). Transdisciplinary research: characteristics, quandaries and quality. *Futures (Elsevier Ltd.)*, 38, 1046–1059.
166. Wilson, E. O. (1998). *Consilience: the unity of knowledge*. New York: Alfred A. Knopf.
167. Wolfgang von Goethe. (n.d.) In *Wikipedia*. Retrieved May 15, 2011, from [http://en.wikipedia.org/wiki/Johann\\_Wolfgang\\_von\\_Goethe](http://en.wikipedia.org/wiki/Johann_Wolfgang_von_Goethe)
168. Yin and yang concept. (n.d.) In *Wikipedia*. Retrieved May 24, 2011, from [http://en.wikipedia.org/wiki/Yin\\_and\\_yang](http://en.wikipedia.org/wiki/Yin_and_yang)
169. Zalanga, S. (2009). Interdisciplinary studies and scholarship; Issues, challenges, and implications for “third world” development and social change. *Human Architecture: Journal of the Sociology of Self Knowledge*, 7(3), 57–76.
170. Žižek, S. (2009). *First as Tragedy, Then as Farce*. London: Verso.

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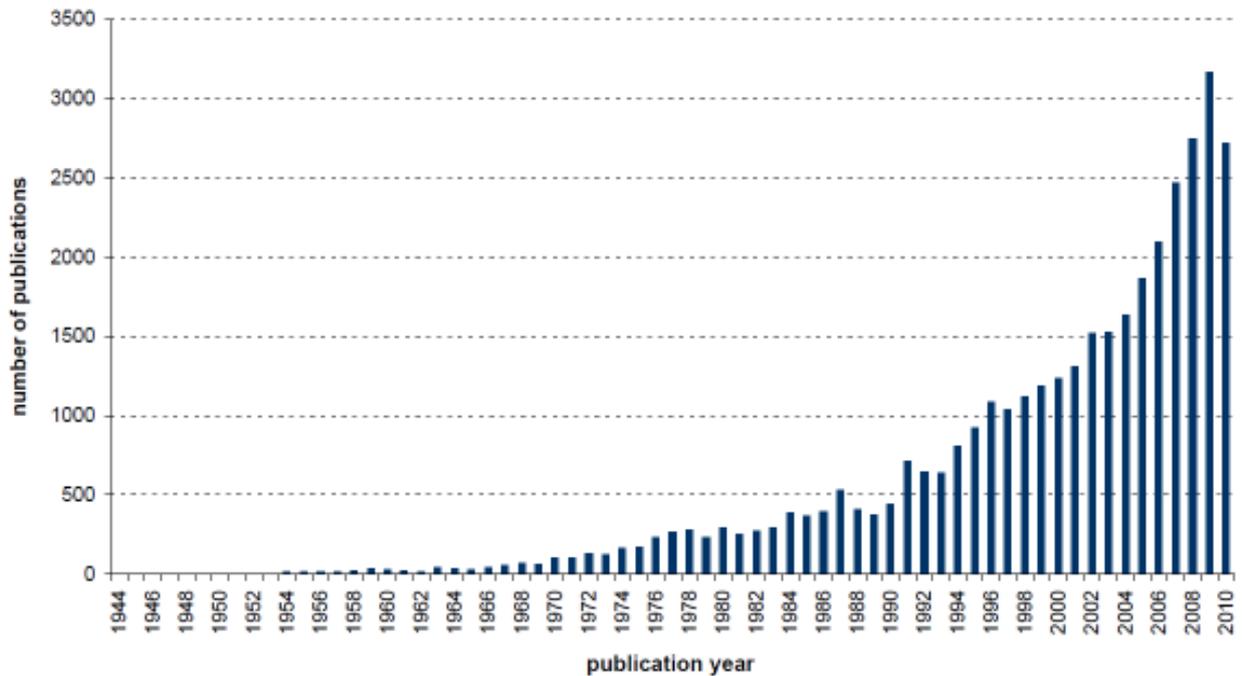
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## **Appendix 1: List of Used Abbreviations**

1. **DESD** – The Decade of Education for SD (2005 to 2014)
2. **DK** – Disciplinary Knowledge
3. **ESD** – Education for Sustainable Development
4. **GDP** – Gross Domestic Product
5. **GST** – General Systems Theory
6. **“IN VITRO”** – Institutions with weak TD integration
7. **“IN VIVO”** – Institutions with great TD integration
8. **OECD** – Organization for Economic Cooperation and Development
9. **SD** – Sustainable Development
10. **TD** – Transdisciplinarity, Transdisciplinary
11. **TK** – Transdisciplinary Knowledge
12. **UN** – United Nations
13. **UNESCO** – United Nations Educational, Scientific and Cultural Organization

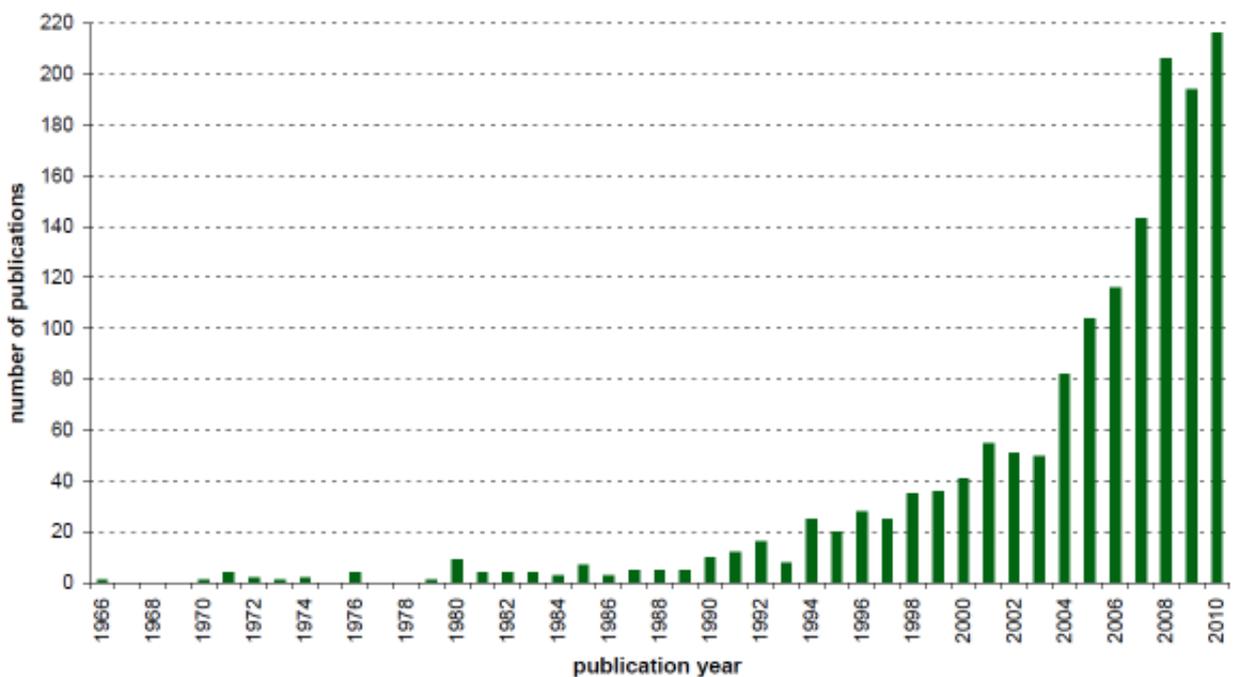
## Appendix 2: Types of Disciplinary Integration

Figure 35: Number of interdisciplinary publications per year



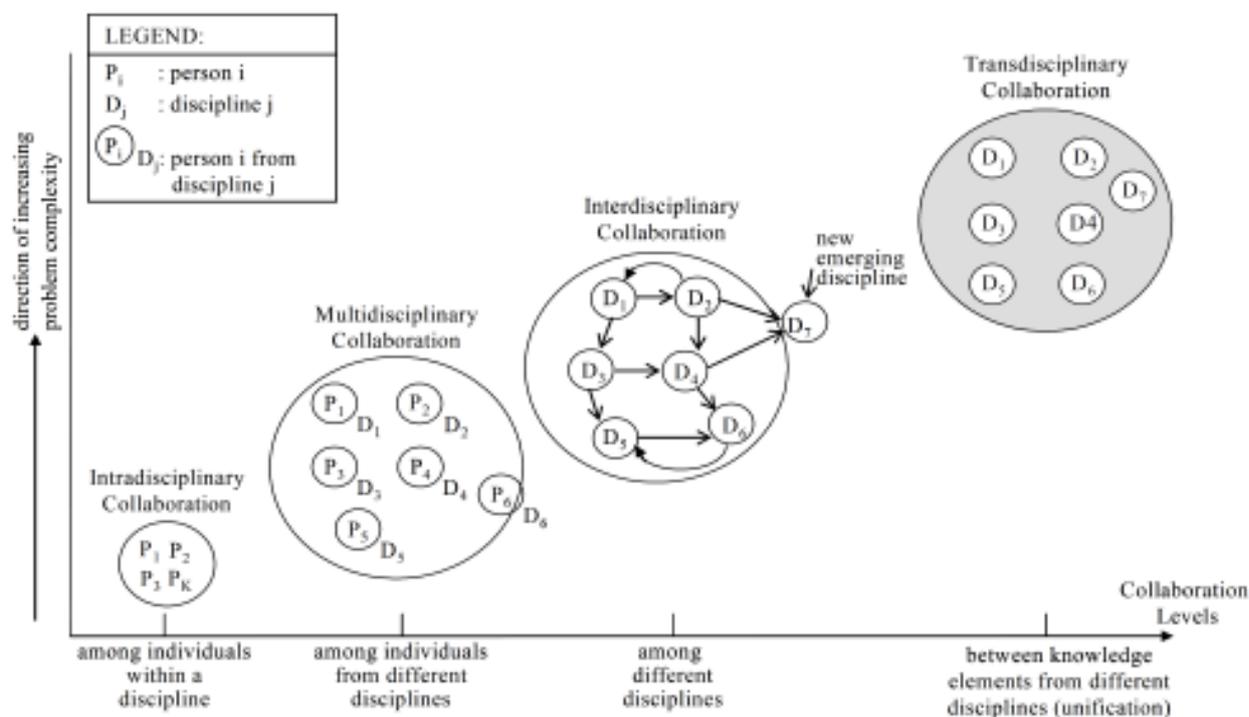
Source: Web of Knowledge, 2011.

Figure 36: Number of TD publications per year



Source: Web of Knowledge, 2011.

Figure 37: Road to TD



Source: A. M. Madni, *Transdisciplinarity: reaching beyond disciplines to find connections*, 2007, p. 4.

Table 8: Example of various GDP perceptions

Example of GDP perceptions
<b>Intradisciplinary:</b> GDP refers to the market value of all final goods and services produced within a country in a given period. It is considered an indicator of a country's standard of living.
<b>Multidisciplinary:</b> GDP is limited; measuring only marketed economic activity or gross income. It also counts all of the activity as positive (socially useful). For example, an oil spill increases GDP because someone has to clean it up.
<b>Interdisciplinary:</b> From the perspective of GDP, more crime, more sickness and war, pollution, more fires, storms and pesticides are all potentially good things, because they can increase marketed activity in the economy. GDP also leaves out many things that enhance well-being, but are outside the market. For example, the unpaid work of parents caring for their own children at home does not show up, nor does the non-marketed work of natural capital in providing clean air and water, food, climate regulation and other ecosystem services, estimated in aggregate to be worth significantly more than GDP.
<b>TD:</b> GDP takes no account of the distribution of income among individuals, since an additional 1€ worth of income produces more well-being if one is poor rather than rich. GPI (Genuine Progress Indicator) addresses these problems by separating the positive from the negative components of marketed economic activity. It also adds in estimates of the value of non marketed goods and services provided by natural, human and social capital, and adjusts for income – distribution effects. From this perspective United States has been in recession since 1975.

Source: A. M. Madni, *Transdisciplinarity: reaching beyond disciplines to find connections*, 2007, p. 3;  
R. Costanza, *Toward an Ecological Economy*, 2006, p. 26.

Table 9: Types of disciplinary integration

<b>Monodisciplinary</b>	Members of one discipline work on a problem or issue, alone.
<b>Multidisciplinary</b>	Members of one discipline turn to people in other disciplines to help them solve a problem. Even if people mingle to solve a problem, each discipline retains its independence, temporarily taking direction from other disciplines. The work is grounded in only one discipline.
<b>Crossdisciplinary</b>	Each discipline contributes what knowledge it has to address the problem, often within a tight time frame, or a particular context. No effort is made to integrate the shared knowledge. Contributions remain separate, and parallel.
<b>Pluridisciplinary</b>	In order to be competent to practice or work in one discipline, one has to use knowledge from another discipline. Knowledge is generated in separate disciplines. But, people cannot work without drawing on these wide knowledge bases.
<b>Interdisciplinary</b>	Coordinated interaction among several disciplines occurs to generate new applications of knowledge, new analyses, even new disciplines. In addition to people offering expertise from their respective discipline, an attempt is made to integrate the information through synergy.
<b>Postdisciplinary</b>	People from different disciplines leave this disciplinary familiarity behind so they can challenge the discipline's assumptions, discuss different contributions from other disciplines, and explore insights and concepts that are possible beyond the walls of disciplines. They pay more attention to the <i>learning</i> that can happen, following ideas and connections where they lead, instead of stopping at disciplinary walls.
<b>Narrow (hybrid) TD</b>	Still within the confines of the academy, disciplinary boundaries are more flexible, permeable, fuzzy. People challenge the exclusivity of fields of knowledge, and attendant notions of truths. They attempt to remove barriers between disciplines, barriers that previously blocked synergy - they take down disciplinary walls.
<b>TD (between, across and beyond disciplines)</b>	Far beyond the academy, the synergy created at the interface between the academy (disciplines) <i>and</i> civil society is woven together to create new kinds of shared knowledge that shed light on the complex problems of humanity.

Source: S. L. T. McGregor, *Consumer scholarship and transdisciplinarity*, 2007.

Table 10: Research typology

	<b>Intradisciplinary</b>	<b>Multidisciplinary</b>	<b>Interdisciplinary</b>	<b>TD</b>
<b>Scope</b>	<ul style="list-style-type: none"> <li>• Collaboration among individuals within a single discipline</li> </ul>	<ul style="list-style-type: none"> <li>• Collaboration among individuals from different disciplines</li> </ul>	<ul style="list-style-type: none"> <li>• Collaboration among different disciplines</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge unification across disciplines</li> </ul>
<b>Focus</b>	<ul style="list-style-type: none"> <li>• One branch of specialization within the research field (e.g., quantum physics within physics)</li> </ul>	<ul style="list-style-type: none"> <li>• Complex problem management and incompatibility resolution through collaboration</li> </ul>	<ul style="list-style-type: none"> <li>• Creation of integrative solution resulting in mutual enrichment of disciplines</li> </ul>	<ul style="list-style-type: none"> <li>• Finding hidden connections among knowledge elements from different disciplines</li> </ul>
<b>Key Characteristics</b>	<ul style="list-style-type: none"> <li>• Generally, study the same “research objects,” but not always (e.g., multiple branches of modern physics)</li> <li>• Tend to have methodologies in common</li> <li>• Tight communications</li> <li>• Mostly speak a common language</li> <li>• Add to a branch/discipline</li> </ul>	<ul style="list-style-type: none"> <li>• Harmonize multiple, occasionally contradictory/incompatible aspects</li> <li>• Integration between disciplines limited to linking research results</li> <li>• Susceptible to misunderstanding (“traps”); specialized languages</li> <li>• Decision makers can be left unsure about final resolution (lack of coherent view)</li> </ul>	<ul style="list-style-type: none"> <li>• Development of shared concepts, methods, epistemologies for explicit information exchange and integration</li> <li>• Can produce an entirely new discipline, e.g., software economics (Tharp et al., 2001, Boehm 2001)</li> <li>• Specialization creates greater knowledge fragmentation and occasionally contradictory knowledge</li> </ul>	<ul style="list-style-type: none"> <li>• Challenge the norm and generate options that appear to violate convention</li> <li>• Look at problems from a discipline neutral perspective</li> <li>• Employ themes around which to conduct research and build curricula</li> <li>• Redefine disciplinary boundaries and interfaces among disciplines</li> </ul>

Source: A. M. Madni, *Transdisciplinarity: reaching beyond disciplines to find connections*, 2007, p. 3;  
R. Costanza, *Toward an Ecological Economy*, 2006, p. 26.

### **Appendix 3: Charter of TD**

Adopted at the First World Congress of Transdisciplinarity, Convento da Arrábida, Portugal,  
November 2-6, 1994

#### **Preamble**

Whereas, the present proliferation of academic and non-academic disciplines is leading to an exponential increase of knowledge which makes a global view of the human being impossible;

Whereas, only a form of intelligence capable of grasping the cosmic dimension of the present conflicts is able to confront the complexity of our world and the present challenge of the spiritual and material self-destruction of the human species;

Whereas, life on earth is seriously threatened by the triumph of a techno-science that obeys only the terrible logic of productivity for productivity's sake;

Whereas, the present rupture between increasingly quantitative knowledge and increasingly impoverished inner identity is leading to the rise of a new brand of obscurantism with incalculable social and personal consequences;

Whereas, an historically unprecedented growth of knowledge is increasing the inequality between those who have and those who do not, thus engendering increasing inequality within and between the different nations of our planet;

Whereas, at the same time, hope is the counterpart of all the afore-mentioned challenges, a hope that this extraordinary development of knowledge could eventually lead to an evolution not unlike the development of primates into human beings;

Therefore, in consideration of all the above, the participants of the First World Congress of TD (Convento da Arrábida, Portugal, November 2-7, 1994) have adopted the present Charter, which comprises the fundamental principles of the community of TD researchers, and constitutes a personal moral commitment, without any legal or institutional constraint, on the part of everyone who signs this *Charter*.

#### **Article 1**

Any attempt to reduce the human being by formally defining what a human being is and subjecting the human being to reductive analyses within a framework of formal structures, no matter what they are, is incompatible with the TD vision.

#### **Article 2**

The recognition of the existence of different levels of Reality governed by different types of logic is inherent in the TD attitude. Any attempt to reduce Reality to a single level governed by a single form of logic does not lie within the scope of TD.

### **Article 3**

TD complements disciplinary approaches. It occasions the emergence of new data and new interactions from out of the encounter between disciplines. It offers us a new vision of nature and Reality. TD does not strive for mastery of several disciplines, but aims to open all disciplines to that which they share and to that which lies beyond them.

### **Article 4**

The keystone of TD is the semantic and practical unification of the meanings that *traverse* and *lay beyond* different disciplines. It presupposes an open-minded rationality by re-examining the concepts of “definition” and “objectivity”. An excess of formalism, rigidity of definitions and a claim to total objectivity, entailing the exclusion of the Subject, can only have a life-negating effect.

### **Article 5**

The TD vision is resolutely open insofar as it goes beyond the field of the exact sciences and demands their dialogue and their reconciliation with the humanities and the social sciences, as well as with art, literature, poetry and spiritual experience.

### **Article 6**

In comparison with interdisciplinarity and multidisciplinary, TD is multireferential and multidimensional. While taking account of the various approaches to time and history, TD does not exclude a transhistorical horizon.

### **Article 7**

TD constitutes neither a new religion, nor a new philosophy, nor a new metaphysics, nor a science of sciences.

### **Article 8**

The dignity of the human being is of both planetary and cosmic dimensions. The appearance of human beings on Earth is one of the stages in the history of the Universe. The recognition of the Earth as our home is one of the imperatives of TD. Every human being is entitled to a nationality, but as an inhabitant of the Earth is also a transnational being. The acknowledgement by international law of this twofold belonging, to a nation and to the Earth, is one of the goals of TD research.

### **Article 9**

TD leads to an open attitude towards myths and religions, and also towards those who respect them in a TD spirit.

### **Article 10**

No single culture is privileged over any other culture. The TD approach is inherently transcultural.

### **Article 11**

Authentic education cannot value abstraction over other forms of knowledge. It must teach contextual, concrete and global approaches. TD education revalues the role of intuition, imagination, sensibility and the body in the transmission of knowledge.

### **Article 12**

The development of a TD economy is based on the postulate that the economy must serve the human being and not the reverse.

### **Article 13**

The TD ethic rejects any attitude that refuses dialogue and discussion, regardless of whether the origin of this attitude is ideological, scientific, religious, economic, political or philosophical. Shared knowledge should lead to a shared understanding based on an absolute *respect* for the collective and individual Otherness united by our common life on one and the same Earth.

### **Article 14**

*Rigor*, *openness*, and *tolerance* are the fundamental characteristics of the TD attitude and vision. *Rigor* in argument, taking into account all existing data, is the best defense against possible distortions. *Openness* involves an acceptance of the unknown, the unexpected and the unforeseeable. *Tolerance* implies acknowledging the right to ideas and truths opposed to our own.

### **Article Final**

The present Charter of TD was adopted by the participants of the first World Congress of TD, with no claim to any authority other than that of their own work and activity. In accordance with procedures to be agreed upon by TD-minded persons of all countries, this Charter is open to the signature of anyone who is interested in promoting progressive national, international and transnational measures to ensure the application of these Articles in everyday life.

Convento da Arrábida, 6th November 1994

Source: CIRET, 2011

## Appendix 4: Comparison of Classical Physics, and Quantum Physics Laws and Concepts

Table 11: Comparison of classical physics and quantum physics laws and concepts

Classical Physics	Quantum Physics
<b>Reality</b> – there is one level of Reality, the empirical (physical) reality	<b>Levels of Reality</b> – there are multiple Levels of Reality, including the empirical, that are accessible to humans due to the existence of multiple levels of perception
<b>Determinism</b> - if the initial state is known, one can predict the physical state at another moment of space-time; the classical object is localized in space-time, and is used to describe reality	<b>Indeterminism</b> - it is possible to assign a well-determined trajectory (an exact point of space-time) to a quantum particle; the quantum object is not localized in space-time, and is a part of reality.
<b>Continuity</b> – one cannot pass from one point of space and of time without passing through all intermediate points	<b>Discontinuity</b> – between two points there is nothing, save for quantum notion of the vacuum, a gap of potentialities
<b>Relativity</b> – Reality is single-referential – the doctrine that measurements and perceptions are true only in relation to a given observer at a given place and time; truth becomes what is meaningful or significant within a given context	<b>New Relativity</b> – Reality is multi-referential – no level of Reality constitutes a privileged place from where one could understand all the other levels of Reality
<b>Local causality</b> (separability) – every physical phenomenon can be understood by a continuous chain of cause and effect; the law of physics determine everything that happens and the causation percolates upward, determining what happens all the way up to the top	<b>Global causality</b> (non-separability) – quantum entities continue to interact, never mind the distance between them; a new type of causality that concerns the system of all physical entities, in their ensemble; there are new causal factors and laws at all levels of Reality that also have to be taken into account in order to understand what goes on in the universe.
<b>Completeness</b> – the world is causally closed at the level of a small number of purely physical forces and types of energy; a complex system can be reduced to a description of primary, fundamental entities	<b>Incompleteness</b> – the laws ruling a particular level of Reality are just a part of the ensemble of laws ruling all the levels of Reality; there is no one fundamental level of Reality because each level exists because the other levels exist at the same time
<b>Resistance</b> – to oppose, experience unwillingness and/or unresponsiveness to movement (change in state of motion or rest)	<b>Non-resistance</b> – become open to other perspectives, ideologies, values premises and belief system, inherently letting go of aspects of how one currently knows the world (this movement happens in the quantum vacuum)
<b>Reductionism</b> – an approach to understanding that nature of complex things by reducing them to the interactions of their parts, or to simpler or more fundamental things; the intent is to finally and absolutely capture reality; view complex system from a linear perspective disregarding	<b>Non-reductionism</b> – things can have emergent properties as a whole that are not explainable from the sum of their parts; the whole is more than the sum of its parts and determines how the parts behave and vice versa; view complex systems from nonlinear perspective privileging

continued

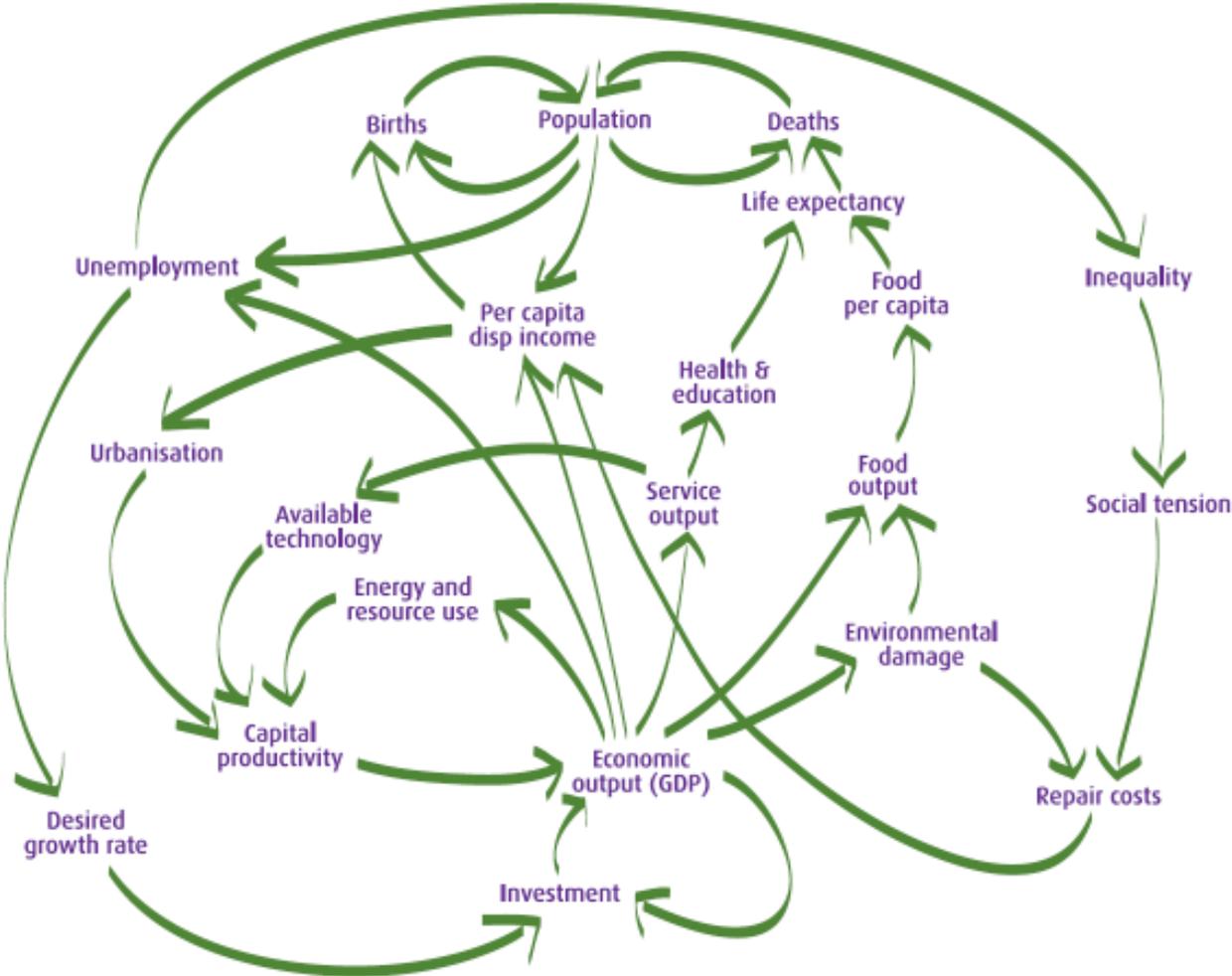
complex phenomena	complex phenomena (holism and emergentism)
<b>Dualism</b> – two sorts of reality (opposites) cannot communicate or act upon each other. One reality has nothing to do with the other – they are totally separate (especially body and mind)	<b>Non-dualism</b> – opposites may be different from each other, but they cannot be separated from each other (superposition of quantum yes and no states, A and non-A to arrive at a third T state)

*Source: B. Nicolescu, Disciplinary boundaries – What are they and how they can be transgressed?, 2010;*

*J. van Breda, Exploring non-reductionism and levels of Reality, 2008.*

**Appendix 5: Dynamics of the economy: cause and effect relationships**

*Figure 38: Dynamics of the economy: cause and effect relationships*



Source: University of Cambridge, 2011.

## Appendix 6: A contradiction in relation to a conflict

A conflict wrongly addresses contradictions. We can solve it only by integrating or by “releasing” contradictions that are the basis for any conflict. Conflict is what it is, Dionysian values are what they are and they cannot be changed, but they can only be accepted or omitted. We can omit them only with the use of the logic of included middle. Development and resolution of conflicts itself does not produce the results; a recursive approach is required while finding and resolving the causes (unreleased contradictions). Conflict is a static barrier that prevents changing of a level of perception. By the nature, a conflict is rigid and does not take into account the contradictions and dynamics arising from contradictions. Conflict can be released when in the first step we find contradictory background, and then overcome the hidden contradictions. The dynamics arise from contradictions, while statics arise from the conflicts.

*Table 12: A contradiction in relation to a conflict*

	<b>CONTRADICTION</b>	<b>CONFLICT</b>
<b>Relationships</b>	Opposing forces are complementary and willing to develop	Struggle between opposing forces for victory or supremacy
<b>Solution</b>	Problem – achievable solution	Struggle/fight – no solution (state of tensions)
<b>Nature</b>	Dynamic	Static, rigid
<b>Differences</b>	Resolvable (disagreement with the content and the meaning)	Irresolvable (deepening of contradictory relationship)
<b>Oppositions</b>	Logical (not ideological) incompatibility	Opposition of needs, values and interests
<b>Result</b>	Disagreement reconciliation (harmony)	Nurturing of tensions among stakeholders
<b>The flow of information and consciousness</b>	Not hindered	Blocked
<b>Logic</b>	Logic of included middle	Binary logic
<b>Levels of Reality</b>	Many levels of Reality	One level of Reality (deadlock)
<b>Values</b>	Apollonian values	Dionysian values
<b>Examples</b>	Friendly competition – opposing groups: left/right; many/little; moderate/extreme; balance/unbalance, etc.	Hostile struggle (fight) to achieve an objective - hostile groups: wars, violence, revolutions or other struggles

System in which we live must be seen from within and from outside, since diversity of views allows us a better understanding. People usually attach to a particular conflict and forget about the cause, i.e., a contradiction; thereby a conflict is nurtured over time. In this way the conflict and the contradictions were not overcome, but rather we have intensified the downward spiral. The conflict arises because of retaining one and the same level of Reality. The ability of

abandonment of attachment to one and the same level of reality, e.g., to the SD conflicts, is a prerequisite for moving toward Apollonian values and comprehensive treatment of SD. "Green reformism" is a typical example of how to put SD in a conflict situation rather than introducing a comprehensive model to address the contradictions before they turn into conflicts.

## Appendix 7: Areas of Science According to Swiss Academies of Arts and Sciences

Table 13: Areas of science according to Swiss Academies Of Arts And Sciences

<b>SOCIAL SCIENCES</b>	<b>MATHEMATICS, NATURAL SCIENCES AND ENGINEERING</b>
Administration and Management Sciences	Agricultural Engineering
Anthropology	Astronomy, Astrophysics and Spatial Sciences
Communication and Journalism	Chemical Engineering
Criminology	Chemistry
Demography	Civil Engineering
Economics	Earth Sciences
Education	Electrical Engineering
Ethnology and Folklore	Fluid Dynamics
History	Forest Engineering
Human and Cultural Geography	Geomorphology
Law	Hydrology, Limnology, Glaciology
Political Sciences	Information Sciences
Psychological and Social Linguistics	Material Sciences
Psychology	Mathematics
Science of Art	Mechanical Engineering
Social Policy	Meteorology and Atmospheric Sciences
Social Psychiatry	Microelectronics, Optoelectronics
Social Psychology	Oceanography
Social and Economic History	Pedology
Sociology	Physics
Urbanism and Spatial Planning	
<b>HUMANITIES</b>	<b>BIOLOGY AND MEDICINE</b>
Ethics, Practical Philosophy	Basic Medical Sciences
Religious Sciences, Theology	Biology
Theoretical Philosophy	Clinical Medicine
	Experimental Medicine
	Preventive Medicine (Epidemiology/ Early Diagnosis/ Prevention)
	Social Medicine

Source: Network for Transdisciplinary Research, 2011.

## Appendix 8: Analysis of Institutions in the SD Field Within All Groups of Google Keywords

Table 14: Analysis of institutions in the SD area of science

	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
1.	<b>CIRET, international center for TD research (non-profit organization)</b>	1987	5	2 & 4	<b>3</b> ; Quantum physics, mechanical engineering environmental studies, philosophy, social sciences and humanities;	<b>7</b> ; The aim of the organization is to develop research in a new scientific and cultural approach - the TD - whose aim is to lay bare the nature and characteristics of the flow of information circulating between the various branches of knowledge.	Paris, France	<a href="http://basarab.nicolescu.perso.sfr.fr/ciret/english/indexen.htm">http://basarab.nicolescu.perso.sfr.fr/ciret/english/indexen.htm</a>	<b>Group 1</b>
2.	The Institute of TD Studies, Woodbury University	2006	4	1 & 4	<b>2</b> ; Environmental Studies and Physics: society, technology, culture, environmental studies, physics and biology;	<b>7</b> ; The Institute emphasizes active, experiential learning techniques designed to enhance the student's capacity for independent creative thought and action.	Burbank, California, USA	<a href="http://www.woodbury.edu/s/131/index.aspx?sid=131&amp;gid=1&amp;pgid=1374">http://www.woodbury.edu/s/131/index.aspx?sid=131&amp;gid=1&amp;pgid=1374</a>	
3.	<b>The Gund Institute for Ecological Economics, University of Vermont</b>	2002	4	2 & 4	<b>3</b> ; Ecological Economics: Behavioral, Cultural, Evolutionary, Growth, Development, History, International, Economic systems, Monetary and Financial economics, Public and Welfare economics, Health, Education, Welfare, Population, Labor, Managerial Business, Information, Industrial organization, Law, Agricultural, Natural resource, Environmental, Ecological, Urban, Rural, Regional, Geography	<b>7</b> ; Ecological economics, natural & social science, management, quantitative methods;	Burlington, Vermont, USA	<a href="http://www.uvm.edu/giee/">http://www.uvm.edu/giee/</a>	
4.	<b>Santa Fe Innovation park (private, not-for-profit, independent research and education center)</b>	/	5	2 & 3 & 4	<b>3</b> ; physical, biological, computational, and social sciences	<b>7</b> ; Understanding of complex adaptive systems is critical to addressing key environmental, technological, biological, economic, and political challenges.	Santa Fe, New Mexico, USA	<a href="http://www.santafe.edu/">http://www.santafe.edu/</a>	

table continues

continued

	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
5.	<b>Network for TD Research, Swiss Academies of Arts and Sciences</b>	2000	2	4	3; Environment, ecology, politics, economy and society;	7; Develops effective strategies for politics, economy and society. Extensive space- and time-dependent processes of different scales are need to be investigated (systems knowledge) and the related problems of controlling and the possibilities of forming and structuring (knowledge of transformation) have to be evaluated.	Bern, Switzerland	<a href="http://www.TD.ch/e/About/">http://www.TD.ch/e/About/</a>	
6.	Claremont Graduate University	2004	1	2 & 4	2; Religion & politics, crisis management, technologies, evolutionary economics, poetry;	5; Provides students with an education that enables them to work collaboratively across multiple fields of study and develop the habits of life-long learning.	Claremont, California, USA	<a href="http://bulletin.cgu.edu/preview_entity.php?catoid=4&amp;ent_oid=162">http://bulletin.cgu.edu/preview_entity.php?catoid=4&amp;ent_oid=162</a>	
7.	<b>TD Laboratory (TdLab), Swiss Federal Institute of Technology Zurich, ETH Zürich (ETHZ)</b>	2002	5	2 & 3 & 4	3; Radioactive waste management, environmental sciences, natural and social sciences (water, soil, air, and anthroposphere);	7; Learn competencies and skills necessary for research in problems of SD. The current focus of the TdLab is on the application of our knowledge, skills and experiences to real(-life), complex, societally-relevant problems shaped by environmental issues, such as radioactive waste management.	Zurich, Switzerland	<a href="http://www.uns.ethz.ch/translab/">http://www.uns.ethz.ch/translab/</a>	
8.	<b>Catamount Center, University of Colorado</b>	2005	4	1 & 2 & 4	3; Sustainability, interactions between human and natural systems, regional geography (physical, cultural, and biological), biogeography, ecological systems;	7; IT investigates the interactions between human and natural systems. Its guiding framework is that sustainability is a human-centered process and not a technological process, though technology can be an important component.	Woodland Park, Colorado, USA	<a href="http://www.catamountcenter.org/TD-education/TD-workshop-faqs/">http://www.catamountcenter.org/TD-education/TD-workshop-faqs/</a>	
9.	The Center for Sustainable Practice in the Arts (CSPA)	2008	5	4	1; Art-making through environmentalism, economic stability, and strengthened cultural infrastructure;	1; The CSPA provides a network of resources to artists and arts organizations by gathering and distributing information from partnering information sources, and through the development of special initiatives designed to enable sustainable practices while maintaining artistic excellence.	Los Angeles, California, USA	<a href="http://www.sustainablepractice.org/">http://www.sustainablepractice.org/</a>	

table continues

continued

	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
10.	Learning development institute	1999	3 (non-profit organization)	3	2; History of humanity and the planet, ecology of that environment, participatory management, learning communities;	7; A TD networked learning community devoted to excellence in the development and study of learning.	Jupiter, Florida, USA	<a href="http://www.learningdevelopment.org/">http://www.learningdevelopment.org/</a>	
11.	Graduate school of frontier science, University of Tokyo	1998	1	2 & 4	2; It is made up of the Division of TD Sciences, the Division of Biosciences, the Division of Environmental Studies, and the Department of Computational Biology;	4; It is independent school for Master and Doctoral students that was <b>established through comprehensive cooperation of all existing departments of the University of Tokyo.</b>	Tokyo, Japan	<a href="http://www.k.u-tokyo.ac.jp/index.html">http://www.k.u-tokyo.ac.jp/index.html</a>	
12.	<b>Babes-Bolyai University of Cluj-Napoca</b>	/	1	2 & 4	3; Exact and human sciences: quantum physics and quantum cosmology, religion, psychoanalysis, law studies, economy, sociology arts and literature;	7; It develops modern and advanced understanding of links between exact and human sciences, facts, people, cultures and religions, based on the TD methodology.	Cluj-Napoca, Romania	<a href="http://basarab.nicolescu.perso.sfr.fr/ciret/DOCTORAT/TD-PhD_BN.pdf">http://basarab.nicolescu.perso.sfr.fr/ciret/DOCTORAT/TD-PhD_BN.pdf</a>	
13.	<b>Stellenbosch University</b>	2009	1	2 & 4	3; SD and sustainability; TD theory; complexity theory; TD methodology; and research paradigms and strategies;	7; It has emerged in response to the global challenge of sustainability and the need for knowledge of complex inter-related social-ecological systems. The complex social-ecological systems problems responsible for Africa's sustainability challenges behave in a non-linear and unpredictable manner, which can affect a diverse range of stakeholders and interest groups in different ways.	Matieland, Stellenbosch, South Africa	<a href="http://basarab.nicolescu.perso.sfr.fr/ciret/DOCTORAT/PhD-Prog_SouthAfrica.pdf">http://basarab.nicolescu.perso.sfr.fr/ciret/DOCTORAT/PhD-Prog_SouthAfrica.pdf</a>	
14.	The Institute for Global Sustainability, University of Vermont	/	4	3	2; Sustainability, sustainable business, collaborative management, food systems, ecodiplomacy, ecological economics;	4; It trains and educates emerging leaders who recognize that there is nothing more relevant and valuable today than understanding and promoting sustainability.	Burlington, Vermont, USA	<a href="http://learn.uvm.edu/sustainability/the-institute-for-global-sustainability/">http://learn.uvm.edu/sustainability/the-institute-for-global-sustainability/</a>	
15.	<b>School of Sustainability, Global Institute of Sustainability, Arizona state university</b>	2007	4	1 & 2 & 3 & 4	3; Environmental, economic, and social sciences; energy, materials and technology, water, international development, ecosystems, social transformations, food and food systems, policy and governance;	7; Programs increase students' understanding of systems dynamics, cascading effects, and scale. Students will learn to organize collaborative TD teams to conduct research and provide adaptive solutions to specific sustainability problems.	Phoenix, Arizona, USA	<a href="http://schoolofsustainability.asu.edu/">http://schoolofsustainability.asu.edu/</a>	

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	<b>Title of the institution (with parent institution)</b>	<b>Founding date</b>	<b>Type<sup>a</sup></b>	<b>Teaching /research activity<sup>b</sup></b>	<b>Degree of TD integration (Scope of disciplines)<sup>c</sup></b>	<b>Area of interest (mission, vision, TD conceptualization )<sup>d</sup></b>	<b>Location</b>	<b>Web site</b>	<b>Group of Google keywords</b>
16.	Cluster of Excellence "Religion and Politics", Westfälische Wilhelms-Universität Münster	2007	3	2 & 4	2; Religion and politics	5; The Cluster of Excellence "Religion and Politics in the Cultures of the Pre-Modern and Modern Eras" deals with the sensitive relationship between religion and politics that has characterized all epochs and cultures. It is the largest research alliance of its kind in Germany and, of the 37 Clusters of Excellence in the country.	Münster, Germany	<a href="http://www.uni-muenster.de/Religion-und-Politik/en/index.shtml">http://www.uni-muenster.de/Religion-und-Politik/en/index.shtml</a>	
17.	<b>The State University of Management</b>	2001	1	1 & 2	3; Human society development, self-management, chemistry, business management, moral aspects, development of a complex system, quantum system, physics, technology, ecology, medicine;	7; The world's community is now facing the problem of developing new rules for the world's economic relations. The problems of a global type demand global thinking, i.e. particularization or changing of the world outlook (Weltanschauung). From this viewpoint, the TD approach seems the most reasonable for solving the global problems, as it presupposes the construction of the World's "image".	Moscow, Russia	<a href="http://www.anoitt.ru/cabdir/materials_eng.php">http://www.anoitt.ru/cabdir/materials_eng.php</a>	
18.	Metanexus Institute	2000	5	4	2; Philosophy, natural history, cultural evolution, science and religion communication, human spirituality;	5; Metanexus promotes scientifically rigorous and philosophically open-ended explorations of foundational questions. It promotes the exchange of innovative and transformational ideas. Metanexus believes that this integrative and exploratory approach is vital to our future wellbeing at this unique moment in the natural history of our planet and the cultural evolution of our species.	New York city, New York state, USA	<a href="http://www.metanexus.net/index.asp">http://www.metanexus.net/index.asp</a>	
19.	<b>Potsdam Institute for Climate Impact Research</b>	1992	5	4	3; Natural and social sciences	7; It addresses crucial scientific questions in the fields of global change, climate impacts and SD. Researchers from the natural and social sciences work together to generate interdisciplinary insights and to provide society with sound information for decision making. The main methodologies are systems and scenarios analysis, modeling,	Potsdam, Germany	<a href="http://www.pik-potsdam.de/pik-frontpage">http://www.pik-potsdam.de/pik-frontpage</a>	

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	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
						computer simulation, and data integration.			
20.	TD Research Organization, University of the Ryukyus	2002	4	4	2; Genetic diversity, ecological diversity, population diversity, taxonomy, ecology;	4; TD Research Organization for Subtropics and Island Studies.	Nishihara, Okinawa, Japan	<a href="http://kenkyusha.db.lab.u-ryukyu.ac.jp/profile/en.du8UiNEeS2prhYJBMwvscA==.html#research_field">http://kenkyusha.db.lab.u-ryukyu.ac.jp/profile/en.du8UiNEeS2prhYJBMwvscA==.html#research_field</a>	
21.	<b>Institute of Ethics and TD Sustainability Research, Leuphana University Lüneburg</b>	2007	4	2 & 4	3; Economics, law, planning, political sciences, ecology, environmental chemistry and environmental communication, business psychology, the natural sciences, engineering and computer science;	7; The distinctive character of the research at Leuphana rests in essence on its clear sustainability orientation and TD, as well as on its balance between the humanities and the natural sciences. These unique characteristics form a promising basis for further growth in the field.	Lüneburg, Germany	<a href="http://www.leuphana.de/en/faculty-sustainability/research.html">http://www.leuphana.de/en/faculty-sustainability/research.html</a>	
22.	<b>Stockholm Resilience Centre, Stockholm University</b>	2007	3	1 & 2 & 3 & 4 (main themes: resilience, adaptation, vulnerability and transformation)	3; History of sciences, Institutional development, Management of urban ecosystem services, Comparative environmental politics, Ecological economics Knowledge management, Physical oceanography, Habitat connectivity, Social-ecological systems, Social and environmental justice, Natural resource management, Carbon economy, Historical regime changes, Global and cross-level dynamics in social-ecological systems, Coastal resource systems, The new economics of complex social-ecological systems, Water resources management, Multi-level adaptive governance, Applied and International Hydrology, Ecosystem services in agricultural landscapes, Agriculture and biodiversity,	7; It is an international centre that advances TD research for governance of social-ecological systems with a special emphasis on resilience - the ability to deal with change and continue to develop. The vision of the Stockholm Resilience Centre is a world where social-ecological systems are understood, governed and managed, to enhance human well-being and the capacity to deal with complexity and change, for the sustainable co-evolution of human civilizations with the biosphere.	Stockholm, Sweden	<a href="http://www.stockholmresilience.org/2.aeea46911a3127427980003200.html">http://www.stockholmresilience.org/2.aeea46911a3127427980003200.html</a>	<b>Group 2</b>

continued

	<b>Title of the institution (with parent institution)</b>	<b>Founding date</b>	<b>Type<sup>a</sup></b>	<b>Teaching /research activity<sup>b</sup></b>	<b>Degree of TD integration (Scope of disciplines)<sup>c</sup></b>	<b>Area of interest (mission, vision, TD conceptualization )<sup>d</sup></b>	<b>Location</b>	<b>Web site</b>	<b>Group of Google keywords</b>
					Atmospheric chemistry and physics, Environmental history, etc.;				
23.	The Beijer Institute of Ecological Economics, Royal Swedish Academy of Sciences	1991	5	2 & 3 & 4	2; Economy and ecology and related disciplines in relation to sustainability	7; Institute's major objective is to carry out research and stimulate cooperation between scientists, university departments, research centers and institutes to promote a deeper understanding of the interplay between ecological systems and social and economic development.	Stockholm, Sweden	<a href="http://www.beijer.kva.se/">http://www.beijer.kva.se/</a>	
24.	ARC Centre of Excellence for Coral Reef Studies, James Cook University	2005	4	4	2; Archaeology, biochemistry, botany, conservation biology, ecology, evolution, fisheries, immunology, modelling, oceanography, paleobiology, petrology, photobiology, physiology, genomics, geochemistry, social science, systematics;	4; Major research themes include adaptation to climate change, understanding and managing biodiversity, marine reserves, fisheries biology, genomics, conservation planning, social studies and governance and policy – in short, the basic and applied science that underpins the sustainable delivery of goods and services from the world’s coral reefs. The trans-disciplinary nature of the Centre’s research was further developed during 2009 with the establishment of two new research programs. The Centre has collaborative links to 345 institutions in 52 countries.	Queensland, Australia	<a href="http://www.coralcoe.org.au/index.html">http://www.coralcoe.org.au/index.html</a>	
25.	Certificate on Humans and the Global Environment, University of Wisconsin-Madison	2007	4	2	2; Atmospheric and oceanic sciences, ecology, environmental studies, veterinary medicine, and sociology;	4; One of the objectives of the program is to train graduate students to work on environmental problems as a group. As part of their training, students are encouraged to expand their collaborative efforts beyond the classroom.	Wisconsin, Madison, USA	<a href="http://www.sage.wisc.edu/igert/index.html">http://www.sage.wisc.edu/igert/index.html</a>	
26.	The Resilience and Adaptation Program, University of Alaska	2002	4	2	2; Ecology, economics, anthropology, political science, the geosciences, and other relevant disciplines	4; The Resilience and Adaptation Program prepares scholars, policy-makers, community leaders, and managers to address issues of sustainability in an integrated fashion.	Fairbanks, Alaska, USA	<a href="http://www.uaf.edu/rap/">http://www.uaf.edu/rap/</a>	

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	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
27.	School of Human Evolution and Social Change, Arizona State University	2005	4	1 & 2 & 4	2; <b>Undergraduate:</b> B.S. in Applied Mathematics for the Life and Social Sciences: environmental, health, life, social, mathematical, physical and computational sciences; <b>Postgraduate:</b> Ph.D. in Environmental Social Science: demography, urbanism, planning, geography, anthropology, sociology and political economy, environmental science, cultural constructs and perceptions, etc.;	7; The School of Human Evolution and Social Change goes beyond the scope that traditionally defines the study of anthropology. By building upon the discipline's chief strength — its holistic, long-term perspective — they recognize a vast range of interests, academic fields and research methods. The school integrates advanced tools and knowledge from across the sciences and social sciences to discover not only who we were, but where we are going and how we may alter our destiny.	Tempe, Arizona, USA	<a href="http://csid.asu.edu/index.php">http://csid.asu.edu/index.php</a>	
28.	International Development, Community, and Environment Department (IDCE), Clark University	2001	1	2 & 4	2; International development, environmental science and policy, community development and planning, technological innovation, government policy, market approaches, social change, social movements, entrepreneurship, individual action, education;	7; The programs approach complex problems by crossing conventional disciplinary boundaries. Each of IDCE's programs is flexible, encouraging students to take courses across programs representing a diversity of perspectives. It is dedicated to fostering environmental sustainability, social justice, and economic well-being in both the developing and developed world. Their commitment to TD means that educational approaches are based inherently on the integration of multiple disciplines and perspectives from a broad array of scholars, practitioners, and stakeholders.	Worcester, Massachusetts, USA	<a href="http://www.clarku.edu/departments/idce/programs/default.html">http://www.clarku.edu/departments/idce/programs/default.html</a>	
29.	<b>Tyndall Centre, Zuckerman Institute for Connective Environmental Research, School of Environmental Sciences, University of East Anglia</b>	2000	4	4	3; Natural sciences, economics, engineering and social sciences;	7; The Tyndall Centre brings together scientists, economists, engineers and social scientists, who together are working to develop sustainable responses to climate change through trans-disciplinary research and dialogue on both a national and international level - not just within the research community, but also with business leaders, policy advisors, the media and the public in general. Their purpose is to research, assess and communicate from a distinct trans-disciplinary perspective,	Norwich, United Kingdom	<a href="http://www.tyndall.ac.uk/">http://www.tyndall.ac.uk/</a>	

continued

	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
						the options to mitigate, and the necessities to adapt to, climate change, and to integrate these into the global, UK and local contexts of SD.			
30.	<b>The Institute Para Limes</b>	2005	5	4	<b>3;</b> Molecular biology, neurosociology, analytical method for network systems, socio-economic systems, combinatory systems;	<b>7;</b> The Institute is a place where new sciences can freely emerge, not hampered by dividing lines between conventional scientific realms or preconceived limits as to what is possible. It provides the inspirational attraction to pull in the best scientists from all over the world to contribute to frontier research on worthy scientific problems of trans-disciplinary nature.	Warnsveld, The Netherlands	<a href="http://wmstest.com/index.htm">http://wmstest.com/index.htm</a>	
31.	<b>International Centre for Integrated assessment and SD (ICIS), Maastricht University</b>	1998	4	1 & 2 & 4	<b>3;</b> Sustainable dynamics, governance for SD, law, economics, SD policy-making, knowledge production for SD, methods and tools of sustainability assessment;	<b>7;</b> The Master programme seeks to deliver graduates that can design, conduct and evaluate sustainability assessments, mostly in an interdisciplinary or TD context. Graduates of this Master can fulfil the role of producer and/or user of integrated knowledge about sustainability issues. Based on this profile, the graduate will be able to fulfil a coordinating and binding role in the analysis of sustainability challenges, by building bridges between different disciplines, domains, sectors and actors.	Maastricht, The Netherlands	<a href="http://www.icis.unimaas.info/">http://www.icis.unimaas.info/</a>	
32.	<b>The International Institute for Industrial Environmental Economics (IIIEE), Lunds Universitet</b>	2000	4	2 (Master's programmes) & 4	<b>3;</b> Business and economics, earth and environmental sciences, sustainability, SD, systems dynamics, evolutionary, development strategy, economics of development, environmental technology, pollution control;	<b>7;</b> The dynamic complexity of environmental and developmental issues can be better understood by utilizing TD theories such as 'General Systems Theory', 'General Evolutionary Theory' and 'Information Theory'.	Lund, Sweden	<a href="http://www.lunduniversity.lu.se/">http://www.lunduniversity.lu.se/</a>	

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	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
33.	<b>The TD Initiative for Global Sustainability (TIGS), Integrated Research System for Sustainability Science. University of Tokyo</b>	2008	4	4	3; Science, technology and the humanities;	7; It aims to create a network-type platform for world-class research and education in the field of sustainability. TIGS aims to develop sustainability science as an academic discipline at the University of Tokyo by building on the University's areas of research specialization and experience.	Tokyo, Japan	<a href="http://en.tigs.ir3.s.u-tokyo.ac.jp/">http://en.tigs.ir3.s.u-tokyo.ac.jp/</a>	
34.	<b>AGS (Alliance for Global Sustainability), Swiss Federal Institute of Technology - Zurich (ETHsustainability), Massachusetts Institute of Technology (MIT/AGS), University of Tokyo, Chalmers University of Technology (Chalmers)</b>	1997	2	4	3; Natural science, technology, and the social sciences;	7; A goal of the AGS is to translate research into action. To achieve this the AGS is committed to wide dissemination of its research results and to improved outreach to industry, government decision-makers, and stakeholders throughout the world who can put these results to the purpose of SD. To this end, research results are quickly shared through workshops and conferences.	Cambridge, Massachusetts USA; Tokyo, Japan; Zürich, Switzerland ; Göteborg, Sweden;	<ul style="list-style-type: none"> <li>●<a href="http://en.ags.dir.u-tokyo.ac.jp/">http://en.ags.dir.u-tokyo.ac.jp/</a></li> <li>●<a href="http://www.globalsustainability.org/">http://www.globalsustainability.org/</a></li> </ul>	
35.	Department of Geography, The Pennsylvania State University	/	4	4	2; Earth sciences, engineering, natural resources, energy, environment, ethics, technology, international affairs;	7; Faculty in Nature/Society work with researchers in numerous fields both on and off campus, and students are encouraged to explore opportunities outside the department. TD connections happen at all possible scales; within the department between individual faculty members in the various sub-specialties of geography, within the college under both independent faculty collaborations and the auspices of centers and institutes, and inter-college efforts such as dual degree programs and university -wide institutes whose specific mission is to support inter-college research	University Park, Pennsylvania, USA	<a href="http://www.geog.psu.edu/research/nature-society/TD-connections">http://www.geog.psu.edu/research/nature-society/TD-connections</a>	

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	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
						efforts.			
36.	Institute for Social-Ecological Research (ISOE)	2001	5	4	2; Social and natural sciences	7; It is dedicated to integrated environmental and sustainability research at both a national and international level. A pre-condition for such research is a TD approach that includes pertinent social players in the research process, collating their 'stake' on problems and their wealth of everyday practical knowledge with scientific problems and insights. This way the Institute aims to develop concepts for practical solutions geared to SD and sustainability research.	Frankfurt am Main, Germany	<a href="http://www.isoe.de/english/profile.htm">http://www.isoe.de/english/profile.htm</a>	
37.	<b>The Center for Rebuilding Sustainable Communities after Disasters (CRSCAD), University of Massachusetts Boston</b>	2007	4	2 & 4	3; Urban and Community Studies, Disaster Reconstruction and Management;	7; It is dedicated to raising awareness and possessing the expertise necessary for long-term sustainable reconstruction. CRSCAD truly encompasses multidisciplinary, TD and cross-disciplinary research activities and assisting local, national and international agencies as well as the victims of disasters to develop practical, sustainable and long-term solutions to the social, economic and environmental consequences of disasters.	Boston, Massachusetts, USA	<a href="http://www.umb.edu/crscad/about/">http://www.umb.edu/crscad/about/</a>	
38.	TD Doctoral School SD, University of Natural Resources and Life Sciences, Vienna (BOKU)	2007	1	2 & 4	2; Natural, social, planning, technical, ecological sciences and economics; climate change, spatial development, tourism and quality of life;	7; The doctoral school "SD" has a strong orientation towards future and wants to give room to unconventional issues and new, innovative ideas. As proVISION focuses on sustainability, inter- and TD are basic aspects of the research processes within this program.	Vienna, Austria	<a href="https://www.boku.ac.at/home.html?&amp;L=1%2F">https://www.boku.ac.at/home.html?&amp;L=1%2F</a>	

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	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching /research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization ) <sup>d</sup>	Location	Web site	Group of Google keywords
39.	<b>McGill School of Environment (MSE), McGill University</b>	1998	4	1 & 2 & 4	3; Agricultural, Environmental Sciences, Arts, Law, Natural Science;	7; MSE aims to stimulate student's passion for life-long learning, their confidence in questioning established norms, their ingenuity and openness to new ideas. They believe that major research achievements will emerge out of a dynamic, interactive community where dialogue occurs among engaged students, staff and faculty from all disciplines. MSE strive to achieve a fully integrated, TD understanding of problems and solutions to the many and interdependent environmental crises in a manner that bridges the social sciences and humanities with the natural and applied sciences.	Montreal, Quebec, Canada	<a href="http://www.mcgill.ca/mse/">http://www.mcgill.ca/mse/</a>	
40.	<b>Institute for Sustainable Solutions (ISS), Portland State University</b>	2006	4	1 & 2 & 3 & 4	3; Architecture, business, education, environmental sciences, mechanical engineering, urban studies, and others;	7; ISS is the focal point for inter and TD sustainability research, teaching and other service. It intends to integrate research and solutions-focused teaching and community engagement. The larger goal is to use this TD research, teaching, and outreach to help create a more sustainable and desirable future.	Portland, Oregon, USA	<a href="http://www.pdx.edu/sustainability/">http://www.pdx.edu/sustainability/</a>	
41.	Amsterdam Institute for Social Science Research (AISSR), University of Amsterdam	2010	4	2 & 4	2; Sociology, political science, anthropology, geography, planning & international development, economic science;	5; The AISSR unites all social science research of the University. The research programme focuses on the functioning of contemporary societies and their interrelationships from historical, comparative and empirical perspectives. Cooperation across these programme groups is institutionalized in four interdisciplinary centers. They develop a TD analytical framework that facilitates participation of stakeholders in research and development of sound integrated policies for sustainable livelihoods.	Amsterdam, The Netherlands	<a href="http://www.ai SSR.uva.nl/ai SSR/home.cfm">http://www.ai SSR.uva.nl/ai SSR/home.cfm</a>	<b>Group 3</b>

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	<b>Title of the institution (with parent institution)</b>	<b>Founding date</b>	<b>Type<sup>a</sup></b>	<b>Teaching /research activity<sup>b</sup></b>	<b>Degree of TD integration (Scope of disciplines)<sup>c</sup></b>	<b>Area of interest (mission, vision, TD conceptualization )<sup>d</sup></b>	<b>Location</b>	<b>Web site</b>	<b>Group of Google keywords</b>
42.	The Institute for Sustainability and Technology Policy (ISTP), Murdoch University	2008	4	2 & 4	2; Ethics, politics, futures and policy;	5; The ISTP is dedicated to interdisciplinary and collaborative research to develop innovative solutions to a range of global, national and local sustainability challenges. An international research reputation was built mainly around the topics of sustainability, urbanization and cities.	Murdoch, Western Australia	<a href="http://www.istp.murdoch.edu.au/">http://www.istp.murdoch.edu.au/</a>	
43.	<b>Environmental, Social and Spatial Change Research Centre, Roskilde Universitet</b>	2006	4	1 & 2 & 4	3; Ecology, environmental planning and governance, mobility, tourism and transport, regional planning and development, urban studies, the workplace environment, landscape science, environmental history, cultural identity, sustainable foods and renewable energy;	7; The purpose of the research is to create knowledge on the interaction between the development of society and nature, which forms the background for planning in relation to environment, energy, production and transport. Foci are on TD problems and include scientific, technological and social aspects of issues related to development and exploitation of nature, resources, infrastructure and technology. An important priority for the Department is strengthening relationships with public and private stakeholders.	Roskilde, Denmark	<a href="http://www.ruc.dk/en/">http://www.ruc.dk/en/</a>	
44.	Transformative Studies, California Institute of Integral Studies	2006	5	2 & 4	2; Spirituality (consciousness), psychology, philosophy, religion, cultural anthropology, leadership, integrative health, and the arts;	5; The course of study is TD. It is inquiry driven rather than driven exclusively by the purview of a single discipline. Students develop a solid grounding in research on transformative studies, the complexities of TD research, and the knowledge base of their topic. The institute strives to embody spirit, intellect, and wisdom in service to individuals, communities, and the Earth.	San Francisco, California, USA	<a href="http://www.ciis.edu/About_CIIS.html">http://www.ciis.edu/About_CIIS.html</a>	
45.	Centre of TD Studies for Development (CETRAD), University of Trás-os-Montes	2005	4	2 & 4	2; Sociology, anthropology, economy and management;	5; The activities of the (CETRAD) fit on the scientific area of Social Studies.	Vila Real, Portugal	<a href="http://www.utad.pt/en/research/cetrad/index.html">http://www.utad.pt/en/research/cetrad/index.html</a>	

**Notes:**

a. Type 1: Single university;

Type 2: Multi-university network;  
Type 3: Multi-research center network;  
Type 4: Research centers embedded in a university;  
Type 5: Research centers not embedded in a university;  
Type 6: Other.

- b. 1: Undergraduate education;  
2: Graduate (masters either/or doctoral either/or postdoctoral) education;  
3: Professional (certificate) programs, i.e., short courses, workshops, independent courses, consultation;  
4: Research.
- c. 1: Almost no TD integration – “IN VITRO”;  
2: Some/moderate TD integration (several areas of SD integrated to create a new concepts/models which influence decisions & actions);  
3: Strong TD integration (inclusion of different stakeholders and also systems thinking approach, complexity, values, TD Subject) – “IN VIVO”.
- d. 1: Economy (human-made capital; producer and consumer goods & services; labor);  
2: Ecosphere (planetary ecosystem, natural capital - source, sink and life-support service);  
3: Sociosphere (institutions, customs, norms, human values, knowledge, beliefs, human beings interrelationships, etc.);  
4: Economy & Ecosphere (1 + 2);  
5: Economy & Sociosphere (1 + 3);  
6: Ecosphere & Sociosphere (2 + 3);  
7: Economy & Ecosphere & Sociosphere (1 + 2 + 3).

## Appendix 9: Analysis of Institutions in the “Other” areas of science

Table 15: Analysis of institutions in the “Other” areas of science

	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching / research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization) <sup>d</sup>	Location	Web site	Area of science
1.	TD Research on Energetics and Cancer (TREC), The National Cancer Institute (NCI), National Institutes of Health (NIH)	2005	5	4	2; Behavior science, physiology and metabolism, sociology, communications, geography, psychology, kinesiology, nutrition, biostatistics, biochemistry, molecular biology, and other diverse disciplines;	5; Scientific research aimed at reducing cancer linked with obesity, poor diet, and low levels of physical activity.	Seattle, Washington state, USA	<a href="http://www.compass.fhrc.org/trec/default.aspx">http://www.compass.fhrc.org/trec/default.aspx</a>	Medicine and Biology
2.	TD Motor Clinic, University of Hawaii	2002	1	3	2; Physics, kinesiology and rehabilitation science, pedagogies;	5; On-campus teaching site for students from various disciplines to teach children in a structured movement environment.	Honolulu, Hawaii, USA	<a href="http://www.coe.hawaii.edu/krs/clinic">http://www.coe.hawaii.edu/krs/clinic</a>	
3.	TD Disease Interest Groups, Institute for Translational Medicine, The University of Chicago	2007	4	2 & 4	2; Biomedical Discovery, Hematology/Oncology, Psychology, Biology, Breast Cancer;	5; Facilitate innovative and interactive discussions among experts working in a particular disease area.	Chicago, Illinois, USA	<a href="http://itm.uchicago.edu/">http://itm.uchicago.edu/</a>	
4.	The TD Tobacco Use Research Center (TTURC), Yale University	2002	4	4	2; Neuroscience, brain imaging, behavioral genetics, the co-morbidity of psychiatric, social context;	5; Was created to help people quit smoking.	New Haven, Connecticut, USA	<a href="http://century.yale.edu/ttunc/index.html">http://century.yale.edu/ttunc/index.html</a>	
5.	TD Research in Energetics and Cancer (TREC), The University of Minnesota	2005	4	2 & 4	1; Bone marrow transplantation, breast cancer, bone cancer, cancer genetics, tobacco research, immunology, new therapies development, pediatric oncology, chemoprevention, epidemiology;	1; Encourages TD research in energetics and cancer.	Twin cities, Minnesota, USA	<a href="http://www.cancer.umn.edu/research/programs/petrec.html">http://www.cancer.umn.edu/research/programs/petrec.html</a>	
6.	Prematurity Research Center, Stanford University School of Medicine and March of Dimes	2010	6	4	1; Neonatology and genetics, computer science and artificial intelligence;	1; Established to identifying the causes of premature birth.	Stanford, California, USA	<a href="http://med.stanford.edu/ism/2011/february/dimes-0228.html">http://med.stanford.edu/ism/2011/february/dimes-0228.html</a>	

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	<b>Title of the institution (with parent institution)</b>	<b>Founding date</b>	<b>Type<sup>a</sup></b>	<b>Teaching / research activity<sup>b</sup></b>	<b>Degree of TD integration (Scope of disciplines)<sup>c</sup></b>	<b>Area of interest (mission, vision, TD conceptualization)<sup>d</sup></b>	<b>Location</b>	<b>Web site</b>	<b>Area of science</b>
7.	Cancer Research Institute, Queen's University	2001	3	3 (Training program in TD cancer research) & 4	1; Biology, Genetics, Epidemiology, Cancer care;	1; Was established to produce future leaders in translational cancer research in Canada.	Kingstone, Ontario, Canada	<a href="http://qcri.queensu.ca/CIHR_Training_Program.html">http://qcri.queensu.ca/CIHR_Training_Program.html</a>	
8.	Center for World Health Promotion and Disease Prevention, College of Nursing and Health Innovation, Arizona State University	2009	4	1 & 2 & 4	2; Education, nursing, public health, social sciences and medicine;	5; It develops collaborations and implements culturally responsive health promotion and disease prevention interventions for the purpose of improving physical and mental health outcomes across the globe.	Phoenix, Arizona, USA	<a href="http://nursingandhealth.asu.edu/worldhealth">http://nursingandhealth.asu.edu/worldhealth</a>	
9.	Center for Interdisciplinary Research on Nicotine Addiction (CIRNA), The University of Pennsylvania	2001	4	2 (postdoctoral) & 4	2; Behavioral Neuroscience, Behavioral Pharmacology, Genetics, Treatment/Medication Development, Tobacco Products and Marketing;	5; Expands knowledge of nicotine withdrawal-related deficits, and develop new models for medication development.	Philadelphia, Pennsylvania, USA	<a href="http://www.med.upenn.edu/cirna/">http://www.med.upenn.edu/cirna/</a>	
10.	Trans-Disciplinary Training in Cancer Biology, Sanford-Burnham Medical Research Institute	/	3	2 (postdoctoral) & 4	1; Postdoctoral training: Cellular signaling, Cell death, Developmental biology, Nanotechnology, Bioinformatics and Molecular epidemiology;	1; Focuses on basic and translational aspects of cancer research, which offers trans-disciplinary training in Cancer Biology.	Santa Barbara, California, USA	<a href="http://www.sanfordburnham.org/training_and_education/postdoctoral_training/trans-disciplinary_training_in.aspx">http://www.sanfordburnham.org/training_and_education/postdoctoral_training/trans-disciplinary_training_in.aspx</a>	

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	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching / research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization) <sup>d</sup>	Location	Web site	Area of science
11.	<b>The Complexity Science Group, University of Calgary</b>	2008	4	4	3; Natural sciences, engineering, medicine, sociology;	7; The mission is to explore new directions in communication, discovery, knowledge creation, and the social organization of research. The Group enhances the manifest connections between the academy and the local community and forges a sustainable society. They tackle problems of structure, organization, and dynamics in diverse settings ranging from living systems and the Earth system to global computing and social dynamics. Particular examples are protein interaction networks, quorum sensing and niche development in microbial communities.	Calgary, Alberta, Canada	<a href="http://www.ucalgary.ca/complexity/">http://www.ucalgary.ca/complexity/</a>	
12.	TD Community-Based Participatory Research Training Program, Siteman Cancer Center, Washington university School of medicine	/	3	3 & 4	2; Medicine (cancer), biology;	5; The goal is to produce accomplished researchers capable of using the tools of community-based, clinical and basic research to establish independent research programs in the service of underserved patients and communities. The program is focused on cross-training academic and community partners in TD community-based participatory research (CBPR) approaches.	St. Louis, Missouri, USA	<a href="http://www.siteman.wustl.edu/contentpage.aspx?id=4389">http://www.siteman.wustl.edu/contentpage.aspx?id=4389</a>	
13.	TD Evaluation and Support Clinic (TEASC), Department of Family and Community Medicine, University of New Mexico	/	4	3 (consultation) & 4	2; Psychiatry, social services and health care systems, clinical social work, neurology, sign language interpretation;	5; TEASC helps adults who have intellectual/developmental disabilities and complex medical, mental health, and support system needs.	Albuquerque, New Mexico, USA	<a href="http://hsc.unm.edu/som/fcm/teasc/teascindex.shtml">http://hsc.unm.edu/som/fcm/teasc/teascindex.shtml</a>	

table continues

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	<b>Title of the institution (with parent institution)</b>	<b>Founding date</b>	<b>Type<sup>a</sup></b>	<b>Teaching / research activity<sup>b</sup></b>	<b>Degree of TD integration (Scope of disciplines)<sup>c</sup></b>	<b>Area of interest (mission, vision, TD conceptualization)<sup>d</sup></b>	<b>Location</b>	<b>Web site</b>	<b>Area of science</b>
14.	Breast Cancer and the Environment Research Center (BCERC), University of Cincinnati, Michigan State, Fox Chase Cancer Center, and University of California-San Francisco (UCSF)	2003	3	4	2; Chemistry, physics, biology, genetics and social environmental factors;	5; A TD study of the effect of environmental exposures on mammary development and potential breast cancer risk. Center groups and individual investigators and outreach experts collaborate across projects, forming TD teams to address complex questions.	Massachusetts, USA	<a href="http://www.bcerc.org/tdresearch.htm">http://www.bcerc.org/tdresearch.htm</a>	
15.	The Bobath Centre	1988	5	2 & 4	2; Neurophysiology and infant development, physiotherapy, motor control, medicine (rehabilitation);	5; The Bobath Concept is an evolving approach to the management and treatment of children and adults with cerebral palsy. It is based on clinical experience and is constantly being developed. The centre actively provides and supports research, education and inter & TD teamwork.	London, United Kingdom	<a href="http://www.bobath.org.uk/index.php">http://www.bobath.org.uk/index.php</a>	
16.	Robarts Research Institute, The University of Western Ontario	2009	4	2 & 4	2; Biology, biophysics and engineering;	5; It support a dynamic, TD training environment aimed to develop research scientists with the expertise necessary to build future TD teams focused on the understanding, treatment and prevention of vascular and cerebrovascular disease.	London, Ontario Canada	<a href="http://www.robarts.ca/">http://www.robarts.ca/</a>	
17.	Institute of Medical Science, University of Toronto	/	4	2 (postdoctoral) & 4	1; Immunology, nursing sciences, medical biophysics;	5; Courses are a TD exploration of hepatitis C, extending the students' understanding of the hepatitis C virus beyond a single discipline in order to enhance pursuits in hepatitis C research or management and prepare the student for a career in hepatitis C research.	Toronto, Ontario, Canada	<a href="http://www.ims.utoronto.ca/Page4.aspx">http://www.ims.utoronto.ca/Page4.aspx</a>	
18.	Kannapolis Scholars (network of eight universities)	2010	2	2 (Masters and Doctorate) & 4	2; Chemistry, molecular biology, genomics, and physiology;	5; TD Training Program in Functional Foods, Bioactive Food Components & Human Health. The complex scientific challenges related to diet and health require a TD approach, one involving an integrated understanding of many disciplines.	Raleigh, North Carolina, USA	<a href="http://www.ncsu.edu/kannapolis/index.html">http://www.ncsu.edu/kannapolis/index.html</a>	

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	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching / research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization) <sup>d</sup>	Location	Web site	Area of science
19.	School of Public Health, University of California	/	1	1 & 2 (doctoral & master's) & 4	3; Biostatistics, epidemiology, epidemiology/biostatistics, environmental health sciences, health policy & management, health services & policy analysis, health & social behavior, infectious diseases & vaccinology, maternal & child health, public health nutrition;	7; Building on a campus tradition of pre-eminent interdisciplinary and TD scholarship, education and public engagement that challenges conventional thinking, the UC Berkeley School of Public Health develops diverse leaders equipped to help solve the health challenges of the 21st century and beyond.	Berkeley, California, USA	<a href="http://sph.berkeley.edu/friends/mission.php">http://sph.berkeley.edu/friends/mission.php</a>	
20.	The Hokkaido University Graduate School of Life Science	2006	1	2 (Master's & doctoral course) & 4	1; Natural sciences such as biology, chemistry, physics or mathematics;	1; In both education and research, field is very wide and that include molecular basis for structure, function and networking of functional biomolecules based on genome information, expression and transduction of bioinformation molecules, regulation mechanism of motility and morphogenesis in cell level and tissue level, and also biomaterial science based on physics and chemistry.	Sapporo, Hokkaido, Japan	<a href="http://www.lfsci.hokudai.ac.jp/graduate-school/bioinformatics/index.html">http://www.lfsci.hokudai.ac.jp/graduate-school/bioinformatics/index.html</a>	
21.	Cognitive Neuroscience Laboratory, Center of Alcohol Studies, Rutgers State University of New Jersey	2001	4	1 & 2 & 4	2; Cognitive psychology, psychophysiology, and neuroscience;	5; It aims at understanding the relation between alcohol and other drug use, cognition, and emotional regulation, and advancing the treatment of addictive behaviors.	Piscataway, New Jersey, USA	<a href="http://alcoholstudies.rutgers.edu/research/prevention_etiology/neuroscience/index.html">http://alcoholstudies.rutgers.edu/research/prevention_etiology/neuroscience/index.html</a>	
22.	Centre for TD Gender Studies, Humboldt University	2008	4	2 (doctoral) & 4	2; Public Law, Gender Studies, European Ethnology, Linguistics, English Literature and Culture;	5; Theories, methodologies and epistemologies in multi-, inter- and TD Gender Studies.	Karlshamn, Sweden	<a href="http://www.intergender.net/?q=node/110">http://www.intergender.net/?q=node/110</a>	Social sciences
23.	Graduate School of Arts and Science, New York University	2007	1	2 (Master's degree) & 4	2; Trauma and Violence TD Studies;	5; Theoretical, critical, and clinical aspects of the analysis and treatment of trauma, violence, and their aftermath.	New York, New York state, USA	<a href="http://tvts.as.nyu.edu/page/home">http://tvts.as.nyu.edu/page/home</a>	

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	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching / research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization) <sup>d</sup>	Location	Web site	Area of science
24.	Department of Foundations and TD Studies, Azusa Pacific University	/	4	2	2; Pedagogics, educational psychology;	5; It provides opportunities for advanced academic work in education.	Azusa, California, USA	<a href="http://www.apu.edu/education/foundations/">http://www.apu.edu/education/foundations/</a>	
25.	International Center for TD Studies ICTS, Jacobs University Bremen	2006	2	3 & 4	2; Mathematics, computer science, astrophysics, physics of complex systems, chemistry and various areas of the life sciences;	4; Organized research in science and engineering through a program of summer schools, workshops, and conferences.	Bremen, Germany	<a href="http://www.jacobs-university.de/ses/icts">http://www.jacobs-university.de/ses/icts</a>	Engineering, natural sciences and mathematics
26.	Department of Mechanical Engineering, Texas Tech University	2010	4	2 (Ph.D. Program) & 4	1; Collaborative, cross-discipline;	1; Emphasis is placed on novel ideas and creative approaches to complex problems.	Lubbock, Texas, USA	<a href="http://www.me.ttu.edu/ME/GraduateProgram/TDDesignProcessandSystemsTrack">http://www.me.ttu.edu/ME/GraduateProgram/TDDesignProcessandSystemsTrack</a>	
27.	TD Fluid Integration Research Center, Tohoku University	2003	4	4	2; Environment, life science, information technology, and nanotechnology;	4; The main purpose of this research center is to address TD fluid problems by means of a new research methodology.	Sendai, Miyagi Prefecture, Japan	<a href="http://www.ifs.tohoku.ac.jp/tfi/index.html">http://www.ifs.tohoku.ac.jp/tfi/index.html</a>	
28.	TD Design department, University of Central Lancashire	/	4	1 & 2	1; Business sciences and technology;	1; Is a direct response to the UK government that stated, for the UK to continue to prosper, it must place creativity, design and innovation at the top of it's agenda in order to give industry the necessary competitive edge.	Preston, United Kingdom	<a href="http://www.uclan.ac.uk/information/courses/ma_TD_design.php">http://www.uclan.ac.uk/information/courses/ma_TD_design.php</a>	
29.	Institute for TD Research In Quantum computing	2005	4	4	1; Computer science, physics (quantum), mechanical engineering, mathematics;	1; It aims at exploiting the strange properties of quantum mechanics to solve various problems arising in computer science and information theory.	Quebec, Canada	<a href="http://www.intriq.org/">http://www.intriq.org/</a>	
30.	School of Design and Engineering, Philadelphia University	2010	1	2 (Master's programs & PhD program) & 4	1; Graphic design communications, industrial design, interactive design, digital animation, fashion design, textile design, textile materials technology, engineering, mechanical engineering, industrial systems engineering, and architectural engineering;	1; It is committed to interdisciplinary academic collaboration and TD professional practice.	Philadelphia, Pennsylvania, U.S.A.	<a href="http://www.philau.edu/">http://www.philau.edu/</a>	

table continues

continued

	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching / research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization) <sup>d</sup>	Location	Web site	Area of science
31.	Graduate School of Science and Technology, Keio University	2007	4	2	2; Various areas of science and engineering;	4; It provides a flexible structure that enables a TD education approach in which students can freely access different fields of study. They encompass a broad range of fields, which students can flexibly choose among.	Minato, Tokyo, Japan	<a href="http://www.st.keio.ac.jp/contents/ic/e/outline/index.html">http://www.st.keio.ac.jp/contents/ic/e/outline/index.html</a>	
32.	Graduate Fellowship Program in Life Sciences, The Virginia Bioinformatics Institute (VBI), Virginia Tech - Virginia Polytechnic Institute and State University	/	4	2 (Ph.D. program) & 4	2; Genetics, Bioinformatics and Computational Biology;	4; VBI is a life science research institute integrating mathematical modeling, simulation and wet laboratories in a TD, team research model. The Institute's mission is to solve some of society's most important problems in the life sciences through TD research and education.	Blacksburg, Virginia, USA	<a href="http://www.vbi.vt.edu/archive/pdf/education_outreach/graduate/tts-fellowship-2009.pdf">http://www.vbi.vt.edu/archive/pdf/education_outreach/graduate/tts-fellowship-2009.pdf</a>	
33.	Master of Arts in TD Studies, Zurich University	/	1	2	1; Art, science, and society;	1; Practical skills for TD art projects, TD work situated between the arts, design, and other fields.	Zurich, Switzerland	<a href="http://www.zhdk.ch/index.php?id=396">http://www.zhdk.ch/index.php?id=396</a>	
34.	Montclair State University	2005	1	3 (education of children from birth through 5 years)	2; Pedagogics, psychology, logopedics, occupational and physical therapy and music therapy;	5; TD teamwork acknowledges the interrelatedness of developmental areas in the progressive growth of a child over time.	Montclair, New Jersey, USA	<a href="http://cehs.montclair.edu/academic/childrenscenter/about.shtml">http://cehs.montclair.edu/academic/childrenscenter/about.shtml</a>	Humanities
35.	TD study of Visual Cultures, University of Wisconsin – Madison	2008	1	2	1; Historiography, Theory and Methods in Visual Culture;	5; It seeks to build a practice-based knowledge of the theories and methods. Builds on the knowledge, theories, and methods that are fundamental to the visual culture.	Madison, Wisconsin, USA	<a href="http://arthistory.wisc.edu/courses/crsdsc801.html">http://arthistory.wisc.edu/courses/crsdsc801.html</a>	

table continues

continued

	Title of the institution (with parent institution)	Founding date	Type <sup>a</sup>	Teaching / research activity <sup>b</sup>	Degree of TD integration (Scope of disciplines) <sup>c</sup>	Area of interest (mission, vision, TD conceptualization) <sup>d</sup>	Location	Web site	Area of science
36.	TD Theological Colloquia	2001	4	3 & 4	2; Philosophy, theology, ethics, feminism, ecology, religio-cultural symbolism, hermeneutics, social justice;	3; By generating a polyglossal matrix of conversation, the TD Theological Colloquia foster a fresh style of theological discourse that is at once self-deconstructive in its pluralism and constructive in its affirmations. Committed to the long-range transformation of religio-cultural symbolism, this series continues Drew's deep history of engaging historical, biblical and cultural hermeneutics, current philosophy, practices of social justice and experiments in theopoetics.	Madison, New Jersey, USA	<a href="http://depts.drew.edu/tsfac/colloquium/index.html">http://depts.drew.edu/tsfac/colloquium/index.html</a>	
37.	Confluence: Center for Creative Inquiry, The University of Arizona	2010	4	3 & 4	2; Arts, humanities, and social science, history, Anthropology, Culture, Language and Literacy;	5; Confluence's mission is to be a world class incubator for TD research and creative activities centered around the question, "What are some of the current grand challenges facing humanity?"	Tucson, Arizona, USA	<a href="http://www.confluencecenter.arizona.edu/home">http://www.confluencecenter.arizona.edu/home</a>	
38.	Department of Culture and Global Studies, Aalborg University	2006	4	3 & 4	2; International and national law, crisis management, human rights, moral issues, public opinion, nation-building, humanitarian assistance and military;	5; It is an interfaculty and TD research and education center which focuses on forced migration, refugees and internally displaced persons in a development and international relations perspective. The clusters of the research program are linked together on the basis of the recognition that the objective of development and social change is influenced by globalization as well as affecting the global economy and world order.	Copenhagen, Denmark	<a href="http://vbn.aau.dk/en/organisations/grs--global-refugee-studies%28b86d0156-bb2c-4d4e-ac3a-0df0e3541f06%29.html">http://vbn.aau.dk/en/organisations/grs--global-refugee-studies%28b86d0156-bb2c-4d4e-ac3a-0df0e3541f06%29.html</a>	

**Notes:**

- a. Type 1: Single university;
- Type 2: Multi-university network;
- Type 3: Multi-research center network;
- Type 4: Research centers embedded in a university;
- Type 5: Research centers not embedded in a university;
- Type 6: Other.
- b. 1: Undergraduate education;

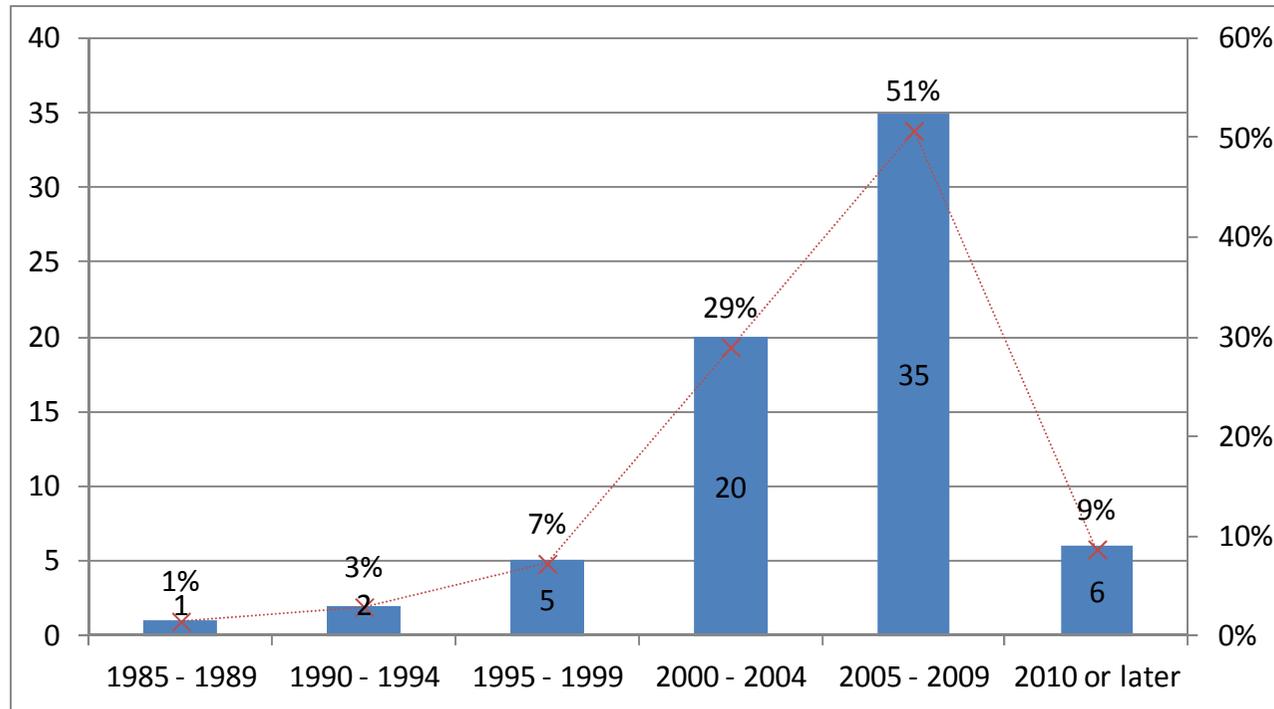
- 2: Graduate (masters either/or doctoral either/or postdoctoral) education;
  - 3: Professional (certificate) programs, i.e., short courses, workshops, independent courses, consultation;
  - 4: Research.
- c.
- 1: Almost no TD integration – “IN VITRO”;
  - 2: Some/moderate TD integration (several areas of SD integrated to create a new concepts/models which influence decisions & actions);
  - 3: Strong TD integration (inclusion of different stakeholders and also systems thinking approach, complexity, values, TD Subject) – “IN VIVO”.
- d.
- 1: Economy (human-made capital; producer and consumer goods & services; labor);
  - 2: Ecosphere (planetary ecosystem, natural capital - source, sink and life-support service);
  - 3: Sociosphere (institutions, customs, norms, human values, knowledge, beliefs, human beings interrelationships, etc.);
  - 4: Economy & Ecosphere (1 + 2);
  - 5: Economy & Sociosphere (1 + 3);
  - 6: Ecosphere & Sociosphere (2 + 3);
  - 7: Economy & Ecosphere & Sociosphere (1 + 2 + 3).

## Appendix 10: Statistical Research Results

Table 16: Number of institutions according to founding date

Year of establishment	1984	1987	1988	1991	1992	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	No data	TOTAL	Average
<b>SD</b>	1	1	0	1	1	1	3	1	4	3	4	0	1	5	4	7	3	1	1	3	45	2002,4
<b>Medicine and biology</b>	0	0	1	0	0	0	0	0	0	3	2	1	0	2	1	1	1	2	2	5	21	2004,2
<b>Social sciences</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	3	2008,0
<b>Engineering, natural sciences and mathematics</b>	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	2	2	8	2006,8
<b>Humanities</b>	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0	1	1	6	2006,2
<b>TOTAL</b>	1	1	1	1	1	1	3	1	4	7	6	2	1	9	7	10	6	3	6	12	83	<b>2003,6</b>

Figure 39: A trend of establishment of the TD institutions



There is an upward trend in establishing TD institutions in the last 30 years (see chart above). The first institution was established in 1987<sup>24</sup>, but most of them were established during the years 2005 and 2009. It can be expected that in time period 2010 – 2014 the trend is going to continue.

<sup>24</sup> CIRET - The International Center for Transdisciplinary Research (CIRET) is a non-profit organization, located in Paris and founded in 1987 by dr. Nicolescu Basarab (CIRET, 2011).

Table 17: Type of TD institutions

	SD		Medicine and biology	Social sciences	Engineering, natural sciences and mathematics	Humanities	TOTAL	TOTAL %
<b>Research centers embedded in a university</b>	23	<b>51%</b>	10	3	6	2	<b>44</b>	<b>53%</b>
<b>Single university</b>	7	<b>16%</b>	3	0	1	4	<b>15</b>	<b>18%</b>
<b>Research centers not embedded in a university</b>	10	<b>22%</b>	2	0	0	0	<b>12</b>	<b>14%</b>
<b>Multi-research center network</b>	3	<b>7%</b>	4	0	0	0	<b>7</b>	<b>8%</b>
<b>Multi-university network</b>	2	<b>4%</b>	1	0	1	0	<b>4</b>	<b>5%</b>
<b>Other</b>	0	<b>0%</b>	1	0	0	0	<b>1</b>	<b>1%</b>
<b>TOTAL</b>	45	100%	21	3	8	6	83	100%

Figure 40: Type of all analyzed institutions

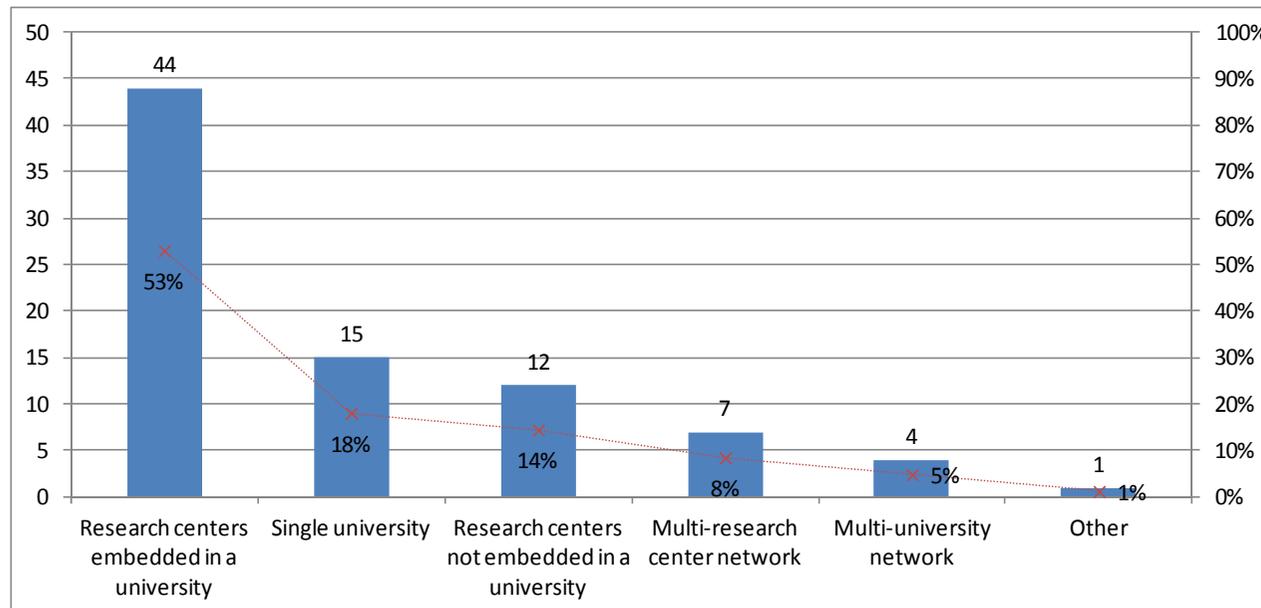


Table 18: Teaching and research activities of the analyzed institutions

	SD		Medicine and biology	Social sciences	Engineering, natural sciences and mathematics	Humanities	TOTAL	TOTAL %
<b>Research</b>	40	<b>45%</b>	20	2	6	3	<b>71</b>	<b>46%</b>
<b>Graduate (masters either/or doctoral either/or postdoctoral) education</b>	30	<b>34%</b>	12	3	5	2	<b>52</b>	<b>34%</b>
<b>Professional (certificate) programs, i.e., short courses, workshops, independent courses, consultation</b>	8	<b>9%</b>	4	0	1	4	<b>17</b>	<b>11%</b>
<b>Undergraduate education</b>	10	<b>11%</b>	3	0	1	0	<b>14</b>	<b>9%</b>
<b>TOTAL</b>	<b>88</b>	<b>100%</b>	<b>39</b>	<b>5</b>	<b>13</b>	<b>9</b>	<b>154</b>	<b>100%</b>

Figure 41: Activities of selected TD institutions

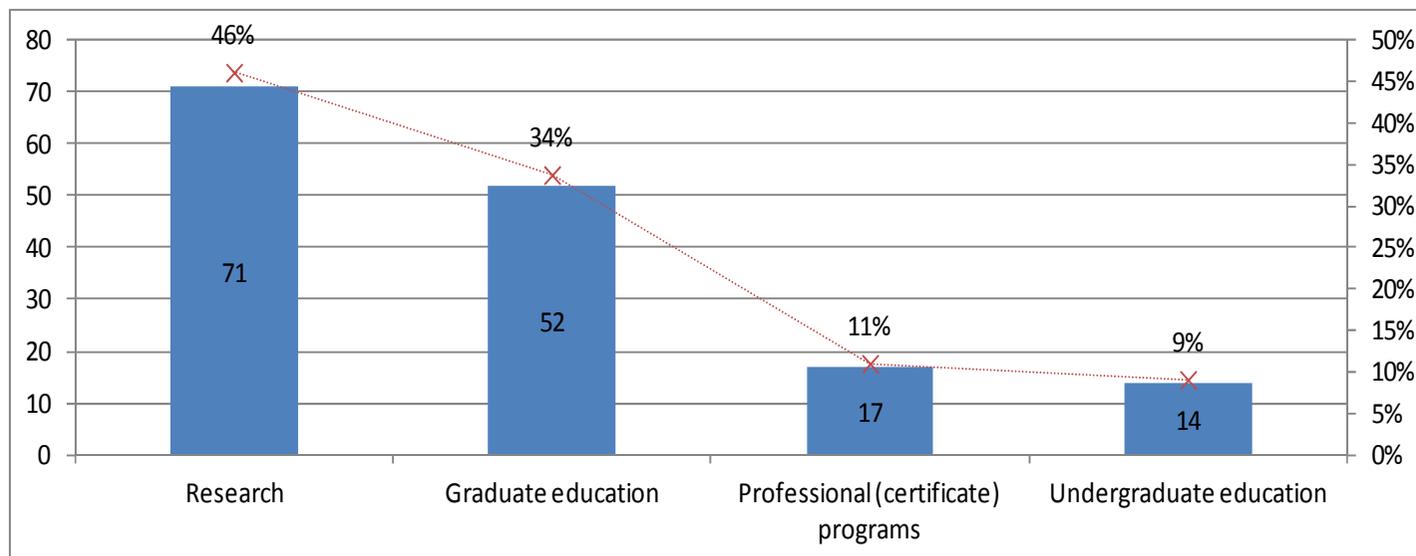


Table 19: Degree of TD integration

	SD		Medicine and biology	Social sciences	Engineering, natural sciences and mathematics	Humanities	TOTAL	TOTAL %
Some/moderate TD integration (several areas of SD integrated to create a new concepts/models which influence decisions & actions)	21	47%	13	3	4	4	45	54%
Strong TD integration (inclusion of different stakeholders and also systems thinking approach, complexity, values, TD Subject) – “IN VIVO”	23	51%	2	0	0	0	25	30%
Almost no TD integration – “IN VITRO”	1	2%	6	0	4	2	13	16%
<b>TOTAL</b>	45	100%	21	3	8	6	83	100%

Figure 42: Degree of TD integration

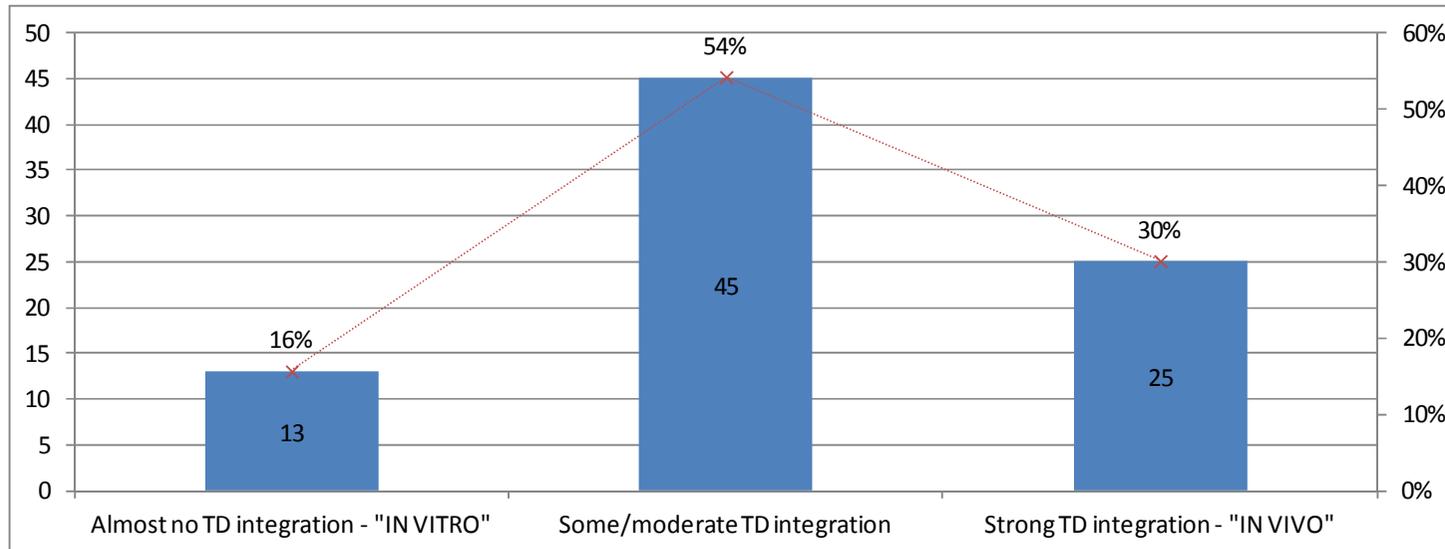


Table 20: Areas of SD in relation to areas of science

	SD		Medicine and biology	Social sciences	Engineering, natural sciences and mathematics	Humanities	TOTAL	TOTAL %
Economy & Ecosphere & Sociosphere	31	69%	2	0	0	0	33	40%
Economy & Sociosphere = 1 + 3	7	16%	14	3	0	4	28	34%
Economy (human-made capital - producer and consumer goods & services; labor)	1	2%	5	0	4	1	11	13%
Economy & Ecosphere = 1 + 2	6	13%	0	0	4	0	10	12%
Sociosphere (institutions, customs, norms, human values, knowledge, beliefs, human beings interrelationships, etc.)	0	0%	0	0	0	1	1	1%
Ecosphere (planetary ecosystem, natural capital - source, sink and life-support service)	0	0%	0	0	0	0	0	0%
Ecosphere & Sociosphere = 2 + 3	0	0%	0	0	0	0	0	0%
<b>TOTAL</b>	45	100%	21	3	8	6	83	100%

Figure 43: Number of institutions in accordance to different areas of SD

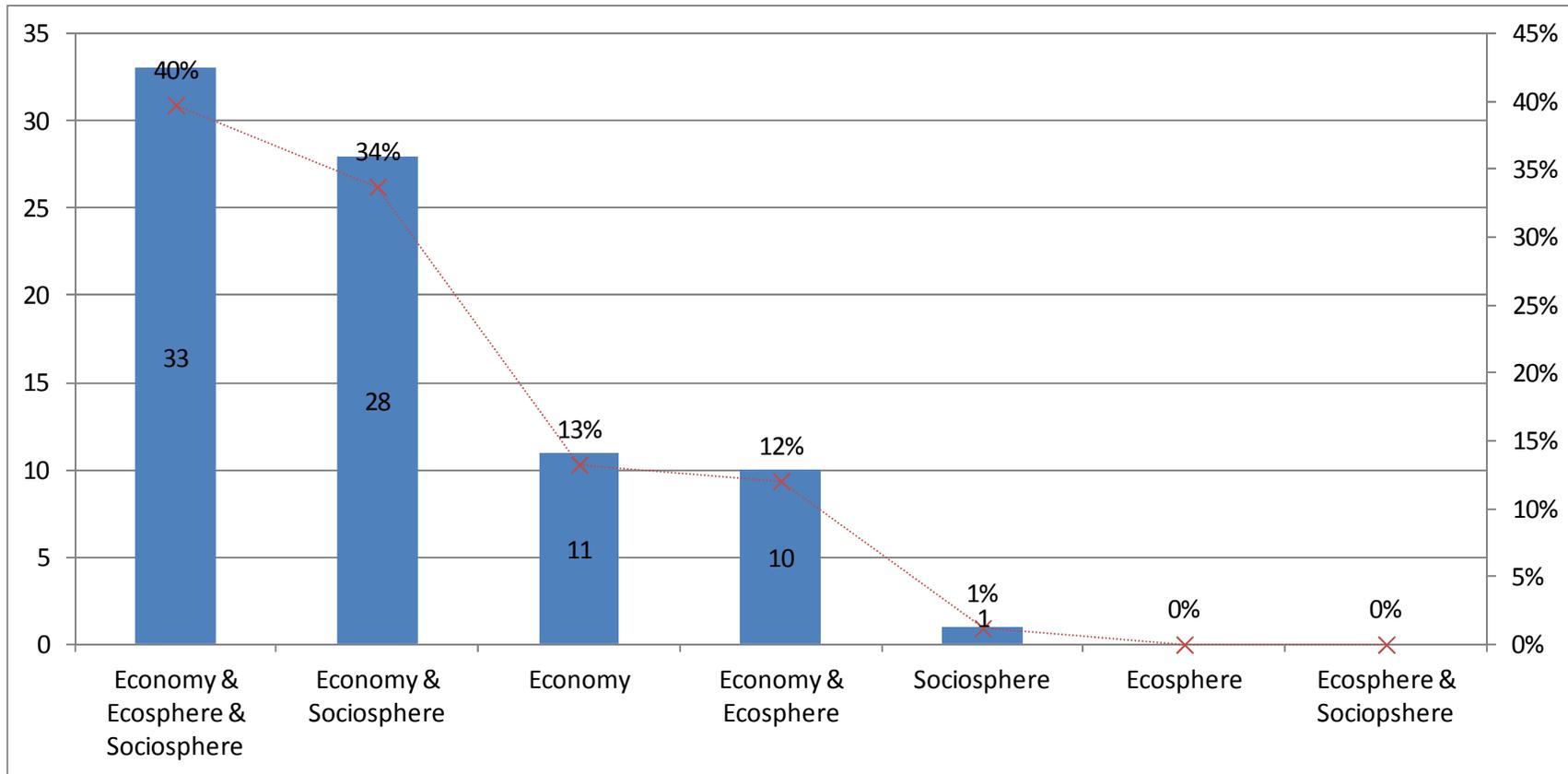
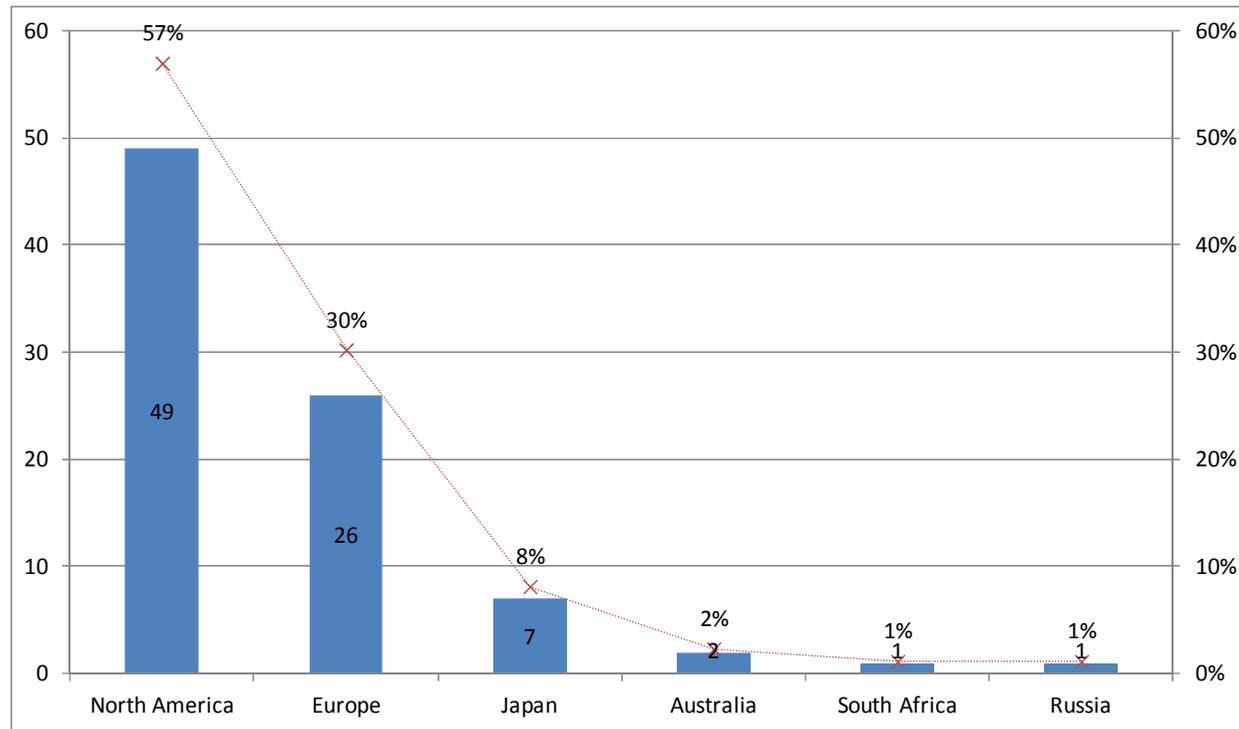


Table 21: Location of the TD institutions

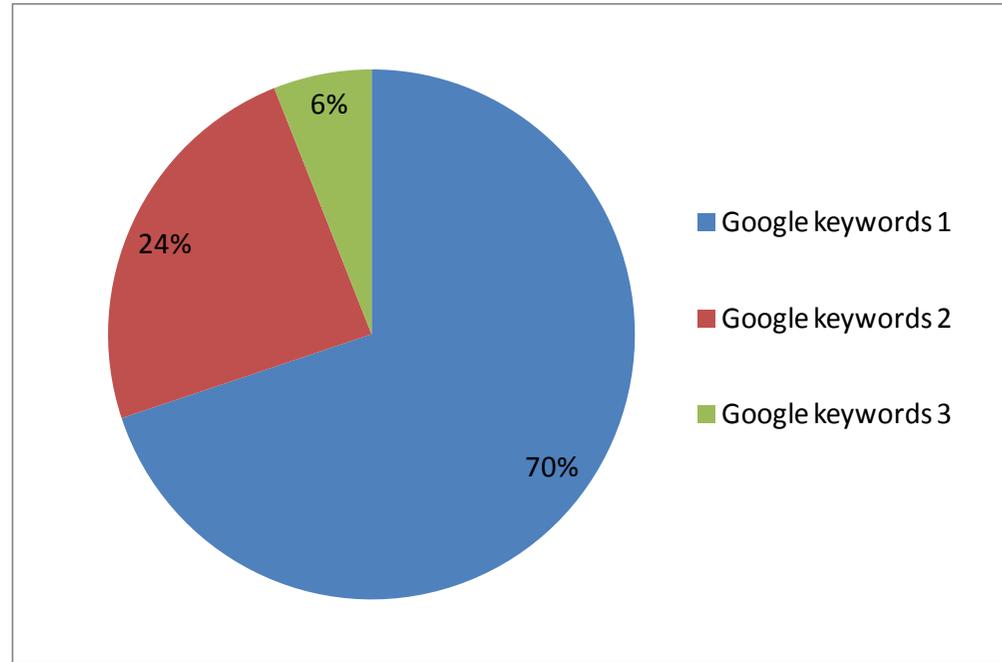
	SD		Medicine and biology	Social sciences	Engineering, natural sciences and mathematics	Humanities	TOTAL	TOTAL %
<b>USA</b>	19	<b>40%</b>	15	2	3	4	<b>43</b>	<b>50%</b>
<b>Japan</b>	4	<b>8%</b>	1	0	2	0	<b>7</b>	<b>8%</b>
<b>Canada</b>	1	<b>2%</b>	4	0	1	0	<b>6</b>	<b>7%</b>
<b>Germany</b>	4	<b>8%</b>	0	0	1	0	<b>5</b>	<b>6%</b>
<b>Sweden</b>	4	<b>8%</b>	0	1	0	0	<b>5</b>	<b>6%</b>
<b>Switzerland</b>	3	<b>6%</b>	0	0	0	1	<b>4</b>	<b>5%</b>
<b>The Netherlands</b>	3	<b>6%</b>	0	0	0	0	<b>3</b>	<b>3%</b>
<b>United Kingdom</b>	1	<b>2%</b>	1	0	1	0	<b>3</b>	<b>3%</b>
<b>Australia</b>	2	<b>4%</b>	0	0	0	0	<b>2</b>	<b>2%</b>
<b>Denmark</b>	1	<b>2%</b>	0	0	0	1	<b>2</b>	<b>2%</b>
<b>France</b>	1	<b>2%</b>	0	0	0	0	<b>1</b>	<b>1%</b>
<b>Romania</b>	1	<b>2%</b>	0	0	0	0	<b>1</b>	<b>1%</b>
<b>South Africa</b>	1	<b>2%</b>	0	0	0	0	<b>1</b>	<b>1%</b>
<b>Russia</b>	1	<b>2%</b>	0	0	0	0	<b>1</b>	<b>1%</b>
<b>Austria</b>	1	<b>2%</b>	0	0	0	0	<b>1</b>	<b>1%</b>
<b>Portugal</b>	1	<b>2%</b>	0	0	0	0	<b>1</b>	<b>1%</b>
<b>TOTAL</b>	<b>48</b>	<b>100%</b>	<b>21</b>	<b>3</b>	<b>8</b>	<b>6</b>	<b>86</b>	<b>100%</b>

Figure 44: Location of the TD institutions



Most of institutions are located in the North America (49), fewer in Europe (26). In Asia there are 8 institutions (7 in Japan and 1 in Russia), the rest of institutions are located in Australia (2) and South Africa (1).

Figure 45: The relative proportions of institutions by three groups of Google keywords



**Appendix 11: “IN VIVO” Institutions Analysis**

*Figure 46: Activities of “IN VIVO” institutions*

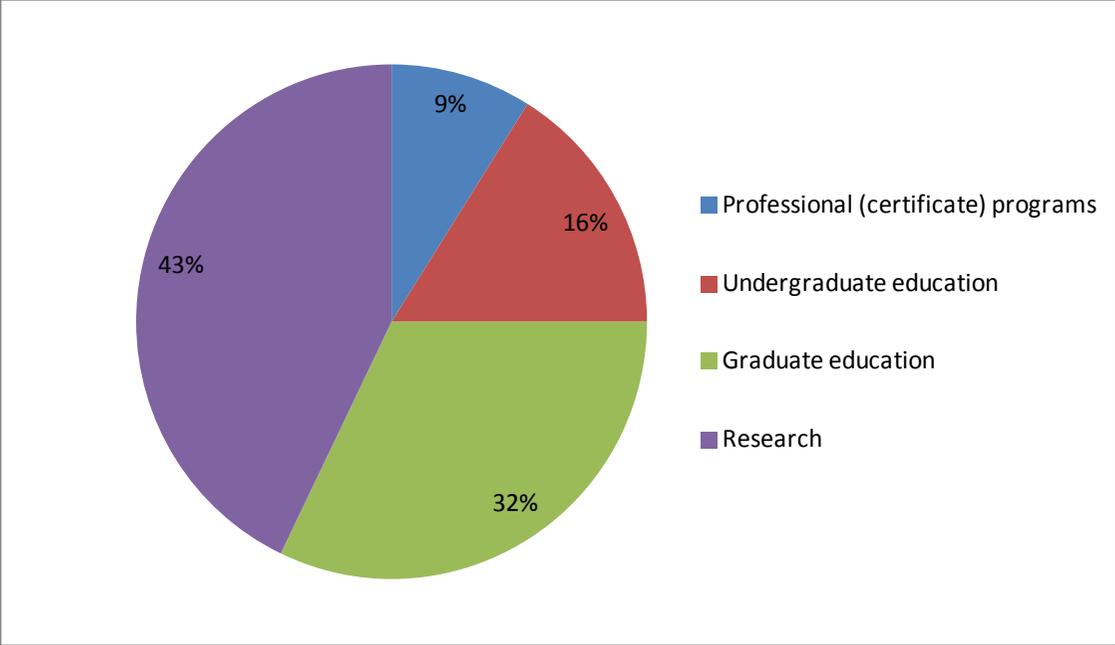
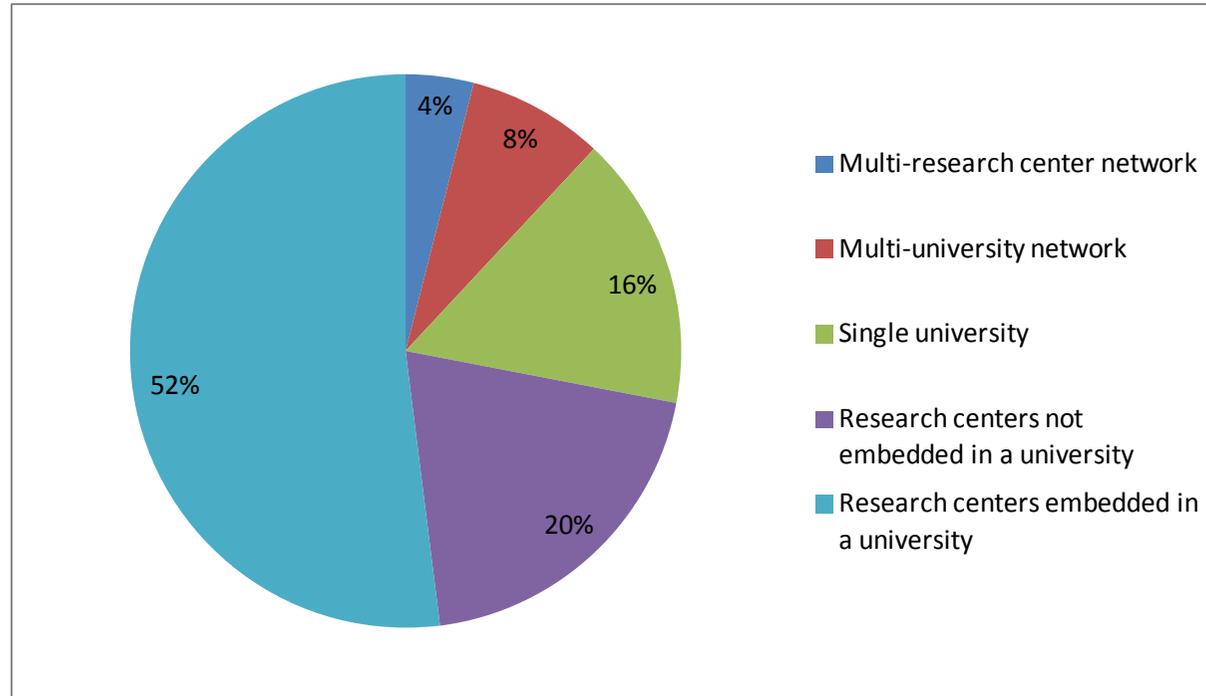


Figure 47: Types of “IN VIVO” institutions



## Appendix 12: Examples of TD Applications

Table 22: Examples of TD approach applications

	TD approaches	Description
1.	<b>Action Research</b>	Action research is an approach in social science research that combines investigation and transformation of social problems within the research process and enables social groups to participate in democratic decision procedures. By experiments in real settings, action, research and learning of all participants are recursively combined as a triangle to develop at the same time valid knowledge and the competences of the social groups to solve the problems.
2.	<b>Adaptive Management</b>	Adaptive management was developed in the USA in the 1970s. The aim of Adaptive Management is to manage natural resources on the basis of a trial and error approach. It involves close collaboration between research and practice. Institutional innovations, transparency with regard to uncertainty and participation are key aspects of this approach.
3.	<b>Assessment of Chemicals</b>	The assessment of chemicals approach integrates scientific and ethical criteria for the assessment of the distribution of chemicals in the environment. It aims to combine scientific criteria and the precautionary principle. The scientific analysis is based on the two criteria of persistence (i.e., life span of a chemical) and spatial reach.
4.	<b>Case Study Method</b>	The case study method was developed by the Department of Environmental Sciences at the ETH in Zurich for an interdisciplinary undergraduate course. The problem definition is taken from a concrete real-life situation for which a decision has to be taken. The method is structured in three distinct phases. The first phase involves the framing of the problem, the second involves e formulation and collection of the required knowledge and the third phase involves knowledge synthesis. The projects involve collaboration between lecturers from several departments of the ETH, students and external experts.
5.	<b>ETH-NSSI Case Study Method</b>	The NSSI case study method was developed by the group Environmental Sciences: <i>Natural and Social Science Interface</i> (NSSI) at the Swiss Federal Institute of Technology (ETH Zurich) for a TD undergraduate course. The NSSI case study encompasses teaching, research and application. Each case study team's activity starts with a comprehensive understanding of the case and its set of problems. The case protagonists are "systems experts of another kind": Their co-operation with students and lecturers not only concerns the definition of problems, but the elaboration of orientations as well. The goal is to achieve a „mutual learning,, process. Both sides stand to gain equally from this dialogue.
6.	<b>Ecological Economics</b>	Ecological economics was developed during the 1970s in the USA with the aim of integrating ecology and economics. The metaphor of a co-evolution of ecological and economic systems lies at the centre of this approach. In contrast to comparable approaches such as human ecology, ecological economics is rooted directly in classical macroeconomics. Ecological services of ecosystems is a key term in ecological economics.
7.	<b>Green</b>	As part of its Green Hydropower project, the Swiss Federal Institute for Environmental Science and Technology (EAWAG)

continued

	<b>Hydropower</b>	developed a label for eco-friendly electricity. In this project, an interdisciplinary team of scientists from the social, natural and economic sciences are working with experts from outside academia.
8.	<b>History of Materials</b>	The keyword “History of Materials” covers approaches which analyze the historical development of the social integration of materials using both historical and scientific methods.
9.	<b>Human Ecology</b>	Human ecology is grounded in geography and aims to develop an integrative perspective on man-environment relationships. This is often done by combining concepts from evolution and system theory.
10.	<b>Industrial Ecology</b>	Industrial ecology focuses on the sustainable conversion of industrial systems. Material-flow analysis and life-cycle assessment are important methods used as part of this approach.
11.	<b>Integrated Assessment</b>	Integrated assessment is a broad research field that focuses on the integrative assessment of the social, economic and ecological consequences of environmental change. An important part of integrated assessment is the combined assessment of the impacts of climate change. Complex computer simulation models are an important instrument used in integrated assessment.
12.	<b>Livelihood Approach</b>	Livelihood approaches deal with the capabilities, assets and activities required for a means of living.
13.	<b>Man and Biosphere (MAB), UNESCO</b>	MAB is a research program that was initiated by UNESCO and aims at establishing an integrative understanding of coupled ecological and social systems on a regional scale. A MAB project on the Alps and tourism was carried out in Switzerland in the 1980s.
14.	<b>Need Field Approach</b>	The need field approach was developed as part of the Swiss Priority Program Environment (SPP Environment). Its basic assumption is that research questions focused on sustainability must be derived from real-life problems. A reduction of the complexity is achieved by applying an approach derived from human action theory. Human actions in a need field, e.g. nutrition, provide the focus for the framing of the problem. The objective of the project was to identify strategies for sustainable nutrition in Switzerland. The heuristic approach “options and restrictions” was developed for this purpose.
15.	<b>Political Ecology</b>	Political ecology deals with the complex relationships between socio-political systems and ecological problems.
16.	<b>Real-World Experiments</b>	In real-world experiments, controlled interventions are carried out under natural (real) conditions and their effects on the dynamics of investigated systems are observed in a process of recursive design.
17.	<b>Social Ecology</b>	Based on the metaphors of metabolism, colonialisation and cultural evolution, an interdisciplinary group of social and natural scientists at the Department of Social Ecology at the Institute for Interdisciplinary Studies of Austrian Universities (IFF) is developing a TD understanding of the relationship between nature and society.
18.	<b>Socio-Ecological</b>	This TD approach to sustainability was initiated by the Institute for Socio-Ecological Research (SOE) in Frankfurt and aims to

continued

	<b>Research</b>	establish a systematic linkage of knowledge concerning systems, goals and implementation strategies and deals with associated methodical problems.
19.	<b>Sustainability Indicators</b>	Sustainability indicators serve in the operationalization of the sustainability concept. The three pillars of sustainability: society, economy and ecology necessitate an interdisciplinary approach.
20.	<b>Syndrome Approach</b>	The syndrome approach was developed by the German Advisory Council on Global Change (WBGU). The approach aims to identify recurring local patterns of global change which are known as syndromes. These global syndromes represent patterns of anthropogenic degradation of the environment. The understanding of the functional interrelations between the identified syndromes provide the basis for the development of problem solving strategies.
21.	<b>SYNOIKOS</b>	The SYNOIKOS project is a collaborative project being implemented by the Institutes of Architecture and Urban Design and Resource and Waste Management at the ETH in Zurich. The aim of the project is to create scenarios for the sustainable conversion of a Swiss urban region. The method aims to establish a link between scientific material-flow analyses and urban design.
22.	<b>Systems Analysis and Modeling</b>	Systems analysis and modeling cover the analysis of systemic relationships as well as their mathematical description in models. Their aim is to describe complex phenomena by changing values of variables.
23.	<b>Earth Systems Analysis</b>	The Earth Systems Analysis approach was developed by the Potsdam Institute of Climate Impact Research (PIK). Its aim is to attain a better understanding of coupled natural and societal systems. The synthesis of the results is based on mathematical models and metaphors drawn from cybernetics.
24.	<b>Technology Assessment</b>	Technology Assessment (TA) attempts to provide policymakers with a rational basis for their decisions. TA proceeds in an interdisciplinary way: ideally, social, economic, technical, legal, ecological, etc. aspects are dealt with together. From a methodological point of view, there is TA that focuses on expert knowledge and there are participatory forms that integrate interest groups, decision-makers and lay people directly in the TA process. Modern, “constructive” TA studies attempt to get involved at a very early stage of the development of a new technology and to shape its very development.

*Source: Network for Transdisciplinary Research, 2011.*

## Appendix 13: Abstract in English

### PROBLEM DEFINITION

Responsibility towards future and present generations generally implies a responsibility to acquire new knowledge. How to establish an environment (conditions) where complex SD questions could be answered and where appropriate knowledge would be developed? To answer this question is the fundamental goal of the master thesis. A contribution to a holistic understanding of SD and an introduction of the concept of TD to Slovenian academic environment is a big challenge. The key goal of the **basic research** in the first section is to integrate SD with the concept of TD and to clarify the notion of the concept of human value in relation to the concept of TD. Last but not least, the goal is also to prepare a glossary of new key terms and translate them in Slovene language and by this, introduce them into Slovenian science. The purpose of the empirical section, i.e., **applied research**, is to find TD institutions around the world and to find out whether these TD institutions operate according to the principles of TD foundation. A fundamental goal is to select institutions which best suit the definition of TD and to find out which factors importantly influence the degree of TD integration. Anyway, the purpose of the master thesis is not focusing on definitions of SD and polycrisis solutions; I rather depict necessary conditions to find holistic systems SD solutions.

Main current SD global problems, like uneven income distribution (poverty and new era slavery), unemployment, overpopulation, neo-imperialism, forced migrations, destruction of ecosystems, governance (neo-liberalism), lack of human development vision, enforced destructive way of living, etc., cannot be adequately tackled from the content of specific individual disciplines. Such problems are complex systems (system-of-systems) problems that require translation between different “vocabularies”. **New ways of thinking are needed** in order to unite traditional disciplines beyond the classical notion of science (traditional boundaries) and to fill the knowledge gaps. SD global problems include not only some of the environmental issues (broadly known as climate change and biodiversity loss), but mostly social issues. They are not bygone problems, but rather they continue to be with us in the current era of globalization where there are **much more losers than winners** (Stiglitz, 2006). Since SD is a systems problem, it logically needs a systems solution, and it cannot be derived from a single specific discipline (e.g. economy). **The meaning of SD is hidden in connections between the different disciplines.**

In December 2002, the United Nations General Assembly, through its Resolution 57/254, proclaimed the years from 2005 to 2014 the Decade of Education for SD. A demand for deep and fundamental change, however, stands in conflict with the continued practice of the industrial development model (The Institute for Social-Ecological Research, 2011). Moreover, Max-Neef (2005) argues that encouraging of **Apollonian values distorts the efficiency of the market**. Adam Smith’s invisible hand is nowadays becoming more visible, not as only orientator of economic activity, but also as (in)visible human greed. Faced with such a situation, development of an ability to deal with transformations is critically needed.

Sustainable world needs to build **responsible, desirable vision**, but this requires imagination that comes not only from rational logic, but from values (Meadows, 1996, p. 117). Consequently, it is impossible to imagine only one solution, but rather **many complex interrelated solutions**. SD means different things to different people. A definition of SD is directly dependent to the specific context being observed. Essentially, the ethical dimension is a core of SD (and also TD) and without this dimension SD is similar to fiction.

The challenge of SD is the central challenge of our time. Great wisdom is needed to realize how to transform capitalism which is possibly the largest, most self-reinforcing, and most seductive and addictive system ever invented (University of Cambridge, 2011). It is quite surprising, that people can easier imagine the end of the world than the end of corporate capitalism. With other words, it is easier for them to imagine the end of infinity (world-cosmos) than the end of finiteness (capitalism). They are not aware of discontinuity of capitalism. **Capitalism**, particularly neoliberal, is a system that supports or even rewards human weakness such as selfishness, greed, corruptiveness as well as prejudice, egoism, individualism, willful denial of knowledge, wrong value system, etc. We have collectively and systemically adopted capitalism, but we are still caught up in the dilemma described by John Maynard Keynes many years ago (year 1933): “Capitalism is not a success. It is not intelligent, it is not beautiful, it is not just, it is not virtuous – and it does not deliver the goods. In short, we dislike it, and we are beginning to despise it. But when we wonder what to put in its place, we are extremely perplexed”.

“**Green reformism**” represents a mainstream response to the current ecological crisis. The term refers to the support for improved technology and resource efficiency combined with a commitment to the logic of capitalism (Rotering, 2011). Frank Rotering believes that it is founded on paradoxical basis, because it simultaneously adopts capitalism and at the same time rejects economic growth. It is committed to capitalism and believes that the same system can achieve long run stability. Although the field has developed comprehensive way of natural resource management, it has quite deficiently defined human well-being. Summing up, “green reformism” is paradoxically trying to save capitalism from collapse.

**Transdisciplinary SD** remains the only seriously “big idea” that underpin Apollonian values such as interdependence, empathy, equity, personal responsibility and intergenerational justice. These human values are the only foundation upon which any feasible vision of a better sustainable world can be constructed (University of Cambridge, 2011). Human values underlying the current economic system may be incompatible with the principles of SD. Today, people’s minds (TD Subject - consciousness, perception, cognition) are considered as largest source of materialistic values, short & near-termism, illiteracy & unawareness and also self-interest & egocentrism. Consequently, these human pitfalls have their effects to other failings such as human behaviors (physical throughput growth, weak leadership, cost/risk externalization, over consumption), position of institutions in society (perverse economic incentives, expansionistic metrics, undemocratic government, societal purpose dissension) and other consequences (socio-economic insecurity, ecological destruction, commoditization of need/want fulfillment, socio-economic inequality).

“The Two Cultures” is the title of an influential 1959 Rede Lecture by British scientist (nuclear physicist) and novelist C. P. Snow. His basic thesis was that the breakdown of communication between the sciences and the humanities, i.e., “the two cultures”, was a major hindrance to solving the world’s problems. His view of science and the arts was formed at Cambridge in the 1930s. Any communicational problem between the arts and the sciences is now characterized by a much more general fragmentation of human learning. In particular, Snow argues that the quality of education in the world is on the decline (Snow, 2011).

### **AVAILABLE SOLUTIONS (disciplinarity, DK, “green reformism”)**

Unfortunately, a number of **past interpretations of SD** have been falsely assumed that ecological, social and economic spheres are independent systems. The circular flow model that forms the centerpiece of the mainstream economic view of the SD process is a case in point. The inadequacy of this approach has led many observers to introduce linkages between the three major systems (Mulder & van den Bergh, 2001).

The present consideration of SD in the literature and media is basically reductionistic and implies mostly binary thinking, e.g., they promote settlement of technology and faster growth of a **“green” GDP**, but not saving nature and human being itself. In this linear, standard view everything is reduced either to society, economy or environment. **The meaning of a self destructive human behavior as well as Apollonian values are completely ignored.** Reductionism, binary logic and disciplinarity (mono-, multi- and interdisciplinarity) approach are misplaced beliefs.

**The “green reformism” acts like that we still have plenty of time** for negotiations, making changes, developing strategies, etc. Therefore, it would be better for the mankind to behave as all was already destroyed (awareness of discontinuity of destruction). When dealing with ecology, we should be aware of **discontinuity of present human behavior**. In the context of SD, human being paradoxically perceives transitoriness (human life) as imperishableness (nature – space, energy, and time) and vice versa. Therefore, consumerism is deeply grounded in human’s minds. It is most likely that radical changes are needed. All of us have prejudices, our representations (horizons), but to overcome these limitations we have to cross different levels of Reality with a help of the logic of included middle (McGregor, 2011). To realize another level of Reality one has to give up an attachment to existent level of Reality and “prepare space” for new Reality.

**Disciplinarity or intradisciplinarity** is about monodiscipline, which represents specialization in isolation. Multidisciplinarity and **interdisciplinarity** overflows the disciplines, but its goal still remains within the framework of disciplinary research (Nicolescu, 2005). In case of interdisciplinary research, there is more communication and collaboration, but the basic approach is to divide a problem into separate components to which each disciplinary expert applies disciplinary methodology, regardless of the problem. It does not solve incompatibilities between disciplines in the quest for knowledge unification. In contrast, TD researchers assess many views of a problem in an integrated way. Nevertheless, integration is much more difficult and much more time consuming than addition of DK. **TD is not a new discipline** or a new

superdiscipline, but is nourished by disciplinary research. In turn, disciplinary research is clarified by TK in a new way. In this sense, **disciplinary and TD research are not antagonistic but complementary** (Nicolescu, 2002).

The TD knowledge, corresponds to a new type of knowledge – “IN VIVO” knowledge. This new knowledge is concerned with the correspondence between the external world of the Object and the internal world of the Subject. By definition, the TK includes a system of human values (Nicolescu, 2005). **TK has no final truth; it is rather evolving and always unifying DK.** Reality depends on us (Nicolescu, 2010), it is plastic (it is created and not given) and our responsibility is to build sustainable future in accordance with Apollonian values.

## **SOLUTION – TD & SD**

As the prefix “trans” indicates, TD concerns that which is at once between the disciplines, across the different disciplines, and beyond all disciplines (Nicolescu, 2002). The word itself is quite recent; it was introduced by Jean Piaget in 1970 (Piaget, 1972). Along with cross-fertilization among disciplines came the recognition that there were incompatibilities among disciplines arising primarily from differences in underlying assumptions and theoretical foundations. These differences demanded knowledge unification across disciplinary boundaries. Such recognition has led to the realization that **we need to transcend or go beyond disciplines** to fill in knowledge voids and harmonize disciplines (Madni, 2007, p. 5). Among others, also **economics** can significantly contribute to the development of effective conservation solutions applicable to SD by exploring complementary approaches focused on the complex, emergent, dynamic interactions amongst disciplines.

The main objective of TD is **to understand the present world** by introducing the unity of knowledge with interactions between knowledge (TD Object) and being (TD Subject). By introducing unity of knowledge, we can develop new TK and unified SD strategy. TD offers an innovative working environment appropriate for finding evolving systems solutions to complex developmental problems. (Baumgärtner, Becker, Frank, Müller & Quaas, 2008, p. 387). One aim of TD research is to get natural and social scientists to collaborate, so as to achieve an integrated view of a subject that goes beyond the viewpoints offered by any particular discipline (Pohl, 2005, p. 1163).

**TD approach can be implied at different levels of social integration.** It offers solutions to the individual, organizational-institutional, regional, and national-global level. The starting point (the source of change), initially occurs at the individual level with the ability to change a level of perception and consequently changing a level of Reality. At the individual level, each individual is left to itself and to his/her personal beliefs to the extent that they are not forced upon him/her from the environment.

- 1. **Individual level:** changing (discontinuity) levels of perception and consequently changing (developing) projections to new levels of Reality (see **Figure 11**); it solves the crisis of human perception, lack of vision and imagination in the SD context.
- 2. **Organizational-institutional level (micro sphere):** TD integration of disciplines and knowledge (especially when they are in conflicts) (see **Figure 12**); result is a new TK and the vision.
- 3. **Regional level:** integration of different stakeholders (non-academic actors and civil society) at early stage of a project, i.e., at goal setting (see **Figure 13**); result is clarification of the regional development vision and solved real world SD problems.
- 4. **National-global level (macro sphere):** opening up opportunities for a change in the socio-political and economic system (see **Figure 13**); solutions are emerging visionary SD systems.

The applied research, in the second section of the master thesis, involves subjects from the organizational and institutional level, i.e., educational and research organizations. Other levels of social integration are not included in the applied research. From the analysis I have found that the solutions of the TD approach are the most common in the second – organizational institutional level. Frequent use of the concept of TD can be also noticed at the regional level (regional TD development projects), while at the national-global level it is widely accepted by the UN especially in the DESD context. However, the use of the concept of TD at the broadest level is still in the nascent emerging phase.

**TD is a new way of thinking and understanding** of complex systems problems since it crosses borders of separated disciplines. Holistic and unified knowledge, which focus is rather positive than normative, can efficiently cope with complex global SD problems. On the other side, the reductionistic or DK unbalances SD and causes a downturn spiral to much deeper global problems. TD represents an epistemological challenge that introduces **quantum logic, as a substitute for linear logic, and breaks with the assumption of a single reality.** (Max-Neef, 2005). While multi- and interdisciplinarity stem from classical physics and sciences, TD is based on quantum physics, chaos theory, living systems theory, consciousness sciences, and other sciences (Nicolescu, 2010). The four pillars of TD determine the methodology of TD research (Nicolescu, 2002): Multiple levels of Reality, The Logic of the Included Middle, Complexity, and Integral human values.

System in which we live must be seen from within and from outside, since diversity of views allows us a better understanding. **People usually attach to a particular conflict and forget about the cause,** i.e., a contradiction; thereby a conflict is nurtured over time. In this way the conflict and the contradictions were not overcome, but rather we have intensified the downward spiral. A conflict arises because of retaining one and the same level of Reality. The ability of abandonment of attachment to one and the same level of reality, e.g., to the SD conflicts, is a prerequisite for moving toward Apollonian values and comprehensive treatment of SD. “Green reformism” is a typical example of how to put SD in a conflict situation rather than introducing a comprehensive model to address the contradictions before they turn into conflicts.

Disciplinary research concerns, at most, one and the same level of Reality. In most cases, it only concerns fragments of one level of Reality. In current era, one can notice predominance of misplaced beliefs such as reductionism, binary logic and disciplinarity. TD does not oppose them; it rather gives them a new meaning. One level of Reality cannot be understood in the terms of the laws and concepts of another level (van Breda, 2008). Every discipline, by itself, has its own content, but no meaning. A discipline gets its meaning only by establishing relations and relationships with other disciplines. However, **two disciplines cannot have the same content, but they can share the same meaning**. TD approach integrates different disciplinary contents under a common meaning within a specific common goal.

## **APPLIED RESEARCH**

The purpose of the applied research is to find TD institutions around the world and to verify whether they operate according to the principles of TD foundation. The focus is on the SD field, while not excluding other areas of science. A fundamental goal is to select institutions which best suit the definition of TD collaboration, i.e., so-called **“IN VIVO” institutions**, and to find out which factors importantly influence the degree of TD integration. While comparing with other institutions, “IN VIVO” would serve as an object of reference. Besides, as research goal is also considered the verifications of the hypothesis.

The applied research showed that the probability to find “IN VIVO” institution is higher when an institution is established earlier (before the year 2000), when it is located in Europe, is active in the field of SD, its type is “Research center embedded in a university”, and is active in research or graduate education. On the other side, the greatest probability (100%) to find an “IN VITRO” institution is when economy is the only area considered from among all areas of SD. It is evident that institutions founded in the recent times (in the last 8 years) lose their comprehensive view of the concept of TD. The reason could be in **abusing TD for commercial – marketing purposes**. In general, North America’s institutions are the most active in integrating economy & sociosphere in the non-SD groups (mostly in medicine and biology); less they integrate all of three SD areas. It can be argued that **Europe is the most successful in adopting and implementing the concept of TD**.

## **FINAL THOUGHT**

There are many **insights for current SD management to be learned**, e.g., the science of complexity, systems thinking, quantum logic (as a substitute for linear logic), axiology, chaos theory, living systems theory, contemporary philosophy, consciousness sciences, and other natural and human sciences; nowadays corporate management does not know how to develop processes for managing the complex real-world problems of sustainable policy and management. Transformation does not mean just a change in worldviews and habits of thinking, but is also a change in people’s experiences and their overall being in the world.

## Appendix 14: Abstract in Slovenian Language

### DOLOČITEV PROBLEMA

Odgovornosti do prihodnjih in sedanjih generacij na splošno vključuje odgovornost za pridobivanje novega znanja. Kako vzpostaviti okolje (pogoje), kjer bi lahko našli odgovore na zapletena vprašanja trajnostnega razvoja (v nadaljevanju TR) in kjer bi hkrati lahko razvili ustrezno znanje? Odgovor na to vprašanje predstavlja temeljni cilj magistrskega dela. Prispevek k celostnemu razumevanju TR in uvajanje koncepta transdisciplinarnosti (v nadaljevanju TD<sup>25</sup>) v slovensko akademsko okolje, je velik izziv. Osnovni cilj **bazične raziskave** v prvem delu magistrskega dela je povezovanje TR s konceptom TD in razjasniti pojem vrednot v zvezi s konceptom TD. In nenazadnje, cilj je tudi pripraviti glosar novih izrazov in jih prevesti v slovenski jezik ter jih s tem uvesti v slovensko znanost. Namen empiričnega dela, t.j., **aplikativna raziskava**, je najti TD institucije po vsem svetu in hkrati ugotoviti, ali te TD institucije delujejo v skladu s TD temeljnimi načeli. Temeljni cilj je izbrati institucije, ki najbolj ustrezajo definiciji TD in ugotoviti, kateri dejavniki pomembno vplivajo na stopnjo TD integracije. Kakorkoli, namen magistrskega dela se ne osredotoča na opredelitev TR in na mnogotere TR rešitve. Namen je prikazati potrebne pogoje, da bi našli celovite rešitve sistemov TR.

Glavni današnji globalni TR problemi, kot so neenakomerne porazdelitve dohodka (revščina in novo obdobje suženjstva), brezposelnost, prenaseljenost, neo-imperializem, prisilne migracije, uničenje ekosistemov, neoliberalizem, pomanjkanje človeške vizije razvoja, vsiljen destruktivni način življenja, itd., se ne morejo ustrezno reševati iz vsebine posameznih disciplin. Takšni problemi so kompleksni sistemski problemi (sistemi sistemov), ki zahtevajo prevode različnih »slovarjev«. **Potrebni so novi načini razmišljanja**, da bi združili tradicionalne discipline preko klasičnega pojmovanja znanosti (tradicionalne meje) in zapolnili vrzeli v znanju. TR globalni problemi ne vključujejo le okoljskih vprašanj (splošno znanih kot podnebne spremembe in izguba biotske raznovrstnosti), ampak tudi socialna vprašanja. Problemi so še vedno z nami v današnjem času globalizacije, kjer je **veliko več poražencev kot zmagovalcev** (Stiglitz, 2006). Ker je TR sistemski problem, je logično da potrebujemo tudi sistemske rešitve, ki jih ni mogoče izpeljati iz ene same discipline (na primer ekonomije). **Pomen TR se skriva v povezavah med različnimi disciplinami.**

Decembra 2002 je Generalna skupščina Združenih narodov s svojo resolucijo 57/254, razglasila leta od 2005 do 2014 za desetletje izobraževanja za TR. Zahteva po globokih, temeljnih spremembah stoji v nasprotju s prakso industrijskega razvojnega modela (The Institute for Social-Ecological Research, 2011). Poleg tega Max-Neef (2005) trdi, da **spodbujanje apolonskih vrednot izkrivlja učinkovitost trga**. Nevidna roka Adama Smitha je danes vse bolj vidna, ne le kot koordinatorka gospodarske dejavnosti, temveč tudi kot (ne)vidni človeški pohlep. Glede na trenutno vsesplošno situacijo, je razvoj sposobnosti za spopadanje z transformacijami nujno potreben.

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<sup>25</sup> TD je okrajšava za »transdisciplinarnost« in za »transdisciplinaren«, odvisno od konteksta.

TR mora zgraditi **odgovorno, zaželeno vizijo** vendar to zahteva domišljijo, ki ne izhaja samo iz racionalne logike ampak iz apolonskih vrednot (Meadows, 1996, str. 117). Zato si je nemogoče zamisliti samo eno rešitev, pač pa **veliko medsebojno zapletenih rešitev**. TR pomeni različne stvari različnim ljudem. Opredelitev TR je neposredno odvisna od specifičnega konteksta. Bistveno je, da je etična dimenzija jedro TR (in tudi TD) in, da je TR brez te dimenzije podoben fikciji.

Izziv TR je osrednji izziv našega časa. Veliko modrosti je potrebno, da bi spoznali kako transformirati kapitalizem, ki je verjetno največji, najbolj samo-krepilen, in najbolj zapeljiv in zasvojen sistem kdajkoli izumljen (University of Cambridge, 2011). Precej presenetljivo je, da si ljudje lažje predstavljajo konec sveta kot konec korporativnega kapitalizma. Z drugimi besedami, lažje si predstavljajo konec neskončnosti (svet-kozmos), kot pa konec končnosti (kapitalizem). Ne zavedajo se diskontinuitete kapitalizma. **Kapitalizem**, predvsem neoliberalni, je sistem, ki podpira ali celo nagrajuje človeške slabosti kot so sebičnost, pohlep, koruptivnost kot tudi predsodke, egoizem, individualizem, namerna zanikanja znanja, napačne sisteme vrednot, itd. Kolektivno in sistemsko smo sprejeli kapitalizem, vendar smo še vedno ujeti v dilemi, ki jo je opisal John Maynard Keynes pred mnogimi leti (leto 1933): »Kapitalizem ni uspeh. Ni inteligenčen, ni lep, ni pravičen, ni kreposten – in ne dostavlja blaga. Skratka, ni nam všeč, in smo ga začeli prezirati. Ko pa se sprašujem, s čim ga naj zamenjamo, smo zelo zmedeni«.

»**Zeleni reformizem**« predstavlja mainstream odziv na trenutno ekološko krizo. Izraz se nanaša na podporo izboljševanju tehnologij in učinkoviti rabi virov v kombinaciji z zavezanostjo logiki kapitalizma (Rotering, 2011). Frank Rotering meni, da je bil ustanovljen na paradoksalni podlagi, saj sprejema kapitalizem in hkrati zavrača gospodarsko rast. Zavezan je kapitalizmu in hkrati meni, da lahko isti sistem doseže dolgoročno stabilnost. Čeprav je »zeleni reformizem« pristop razvil celovit način upravljanja in ravnanja z naravnimi viri, je istočasno precej pomanjkljivo opredelil blaginjo ljudi. Z drugimi besedami, »zeleni reformizem« paradoksalno poskuša rešiti kapitalizem pred propadom.

**Transdisciplinaren TR** ostaja edina resna »velika ideja«, ki podpira apolonske vrednote kot so empatija, občutek soodvisnosti, enakosti, osebna odgovornost, medgeneracijska pravičnosti, ipd. Te vrednote so edini temelj na katerih bi lahko razvili vizijo boljšega trajnostnega sveta (University of Cambridge, 2011). Človeške vrednote na katerih temelji sedanji gospodarski sistem so nezdržljive z načeli TR. Današnji človeški um (TD Subjekt – zavest, zaznavanje, spoznavanje) je največji vir materialističnih vrednot, kratkoročne usmerjenosti, nezavedanja, lastnih interesov in egocentrizma. Te človeške »zablode« vplivajo na druga področja, kot so človekovo vedenje (rast fizične proizvodnje, slabo vodstvo, eksternalizacija stroškov in tveganja, prekomerna potrošnja), položaj institucij v družbi (nepriemerne ekonomske spodbude, ekspanzionistična merila razvoja, nedemokratska vlada, družbena nesoglasja) in na ostale okoliščine (družbeno-gospodarska negotovost, uničenje ekoloških sistemov, poglobljenje zadovoljevanja potrebe/želja, socialno-ekonomske neenakosti).

»Dve kulturi« je naslov vplivnega predavanja (iz leta 1959) s strani britanskega znanstvenika (jedrski fizik) in romanopisca C. P. Snowa. Njegova osnovna teza je bila, da je zlom komunikacije med prirodoznanostmi ter humanističnimi vedami (»dve kulturi«) predstavljal velika oviro za reševanje svetovnih problemov. Njegov pogled na znanost in umetnost je nastal na Univerzi v Cambridgeu leta 1930. Za dandanašnjo komunikacijo med umetnostjo in znanostjo je značilna še toliko veliko večja splošna razdrobljenosti. Snow trdi, da je zaradi te razdrobljenosti kakovost izobraževanja v svetu v upadu (Snow, 2011).

## **RAZPOLOŽLJIVE REŠITVE (disciplinarno znanje, »zeleni reformizem«)**

Žal so številne **pretekle interpretacij TR** napačno sklepale, da so ekološke, socialne in ekonomske sfere neodvisni sistemi. To predpostavlja tudi krožni model, ki je središče mainstream ekonomskega pogleda na TR procese. Neustreznost tega pristopa je spodbudila veliko opazovalcev k vpeljavi povezav med tremi velikimi TR sistemi (Mulder & van den Bergh, 2001).

Sedanja obravnava TR v literaturi in v medijih je bolj ali manj redukcionistična in obsega predvsem binarno razmišljanje, na primer, naklonjeni so spodbujanju razvoja tehnologij in hitrejši rasti **»zelenega« BDP**, ne pa tudi ohranitvi narave in samega človeštva. V tem linearnem, standardnem pogledu je vse reducirano na družbo ali na gospodarstvo ali na okolje. **Smisel samo-destruktivnega človeškega vedenja in tudi vloga apolonskih vrednot so popolnoma prezrte.** Redukcionizem, binarna logika in disciplinarnost (mono-, multi- in interdisciplinarnost) so napačna prepričanja.

**»Zeleni reformizem« ravna tako kot, da imamo še vedno obilo časa** za pogajanja, spremembe, razvijanje strategij, itd. Zato bi bilo za človeštvo bolje, da se obnaša kot, da je bilo že vse uničeno (zavest o diskontinuiteti uničenja). Ko gre za ekologijo, se moramo zavedati **diskontinuitete sedanjega človeškega vedenja.** V kontekstu TR, človek paradoksalno zaznava minljivost (človeško življenje) kot neminljivost (narava – prostor, energija in čas) in obratno. Zato je potrošništvo globoko zasidrano v glavah ljudi. Najbolj verjetno je, da so potrebne korenite spremembe. Vsi imamo določene predsodke, predstave (obzorja), vendar za premagovanje teh omejitev moramo preseči različne ravni Realnosti in to s pomočjo logike vključene sredine (McGregor, 2011). Da bi spoznali novo raven Realnosti se je potrebno odpovedati navezanosti na obstoječo raven in »pripraviti prostor« za novo Realnost.

Pri **disciplinarnosti ali intradisciplinarnosti** gre za monodisciplinarnost, torej za specializacijo v izolaciji. Multidisciplinarnost in **interdisciplinarnost** že presegata disciplinarne ovire, vendar cilj še vedno ostaja v okviru disciplinarnih raziskav (Nicolescu, 2005). V primeru interdisciplinarnih raziskav je več komunikacije in sodelovanja, vendar gre še vedno za pristop, ki razdeli problem v ločene komponente za katere vsak disciplinarni strokovnjak aplicira disciplinarno metodologijo, ne glede na naravo problema. To ne rešuje neskladnosti med disciplinami v prizadevanju za razvoj integriranega znanja. Za razliko, TD raziskovalci na integrativen način ocenjujejo številne poglede na določen problem. Vsekakor je integrativen pristop težji in veliko bolj zamuden v primerjavi s dodajanjem nepovezanega disciplinarnega

znanja. Kakorkoli, **TD ni nova disciplina** ali nova superdisciplina, vendar se kljub temu hrani z disciplinarnim znanjem. V zameno je disciplinarno znanje na nov način pojasnjeno s TD znanjem. V tem smislu si **disciplinarno in TD znanje ne nasprotujeta, ampak se dopolnjujeta** (Nicolescu, 2002).

TD znanje ustreza novi vrsti znanja, t.j., »IN VIVO« znanju. To novo znanje se ukvarja s povezovanjem zunanjega sveta Objekta z notranjim svetom Subjekta. Po definiciji, TD znanje vključuje sistem človeških vrednot (Nicolescu, 2005). **TD znanje nima dokončne resnice, ampak je razvijajoče se in vedno integrira disciplinarno znanje.** Realnost je odvisna od nas samih (Nicolescu, 2010), je plastična (je ustvarjena in ne dana) in naša odgovornost je, da zgradimo trajnostno prihodnost v skladu z apolonskimi vrednotami.

## REŠITVE – TD & TR

Že predpona »trans« označuje, da je TD hkrati med disciplinami, preko različnih disciplin, in na drugi strani vseh disciplin (Nicolescu, 2002). Beseda sama je precej nova, vpeljal jo je Jean Piaget leta 1970 (Piaget, 1972). Skupaj z navzkrižno »oploditvijo« med disciplinami je prišlo do spoznanja, da nezdružljivost med disciplinami izhaja predvsem iz razlik v osnovnih predpostavkah in teoretičnih temeljih (konceptih). Razlike zahtevajo poenotenje znanja preko disciplinarnih meja. Takšna prizadevanja so privedla do spoznanja, da **moramo transcendirati ali iti onstran disciplin**, da bi zapolnili vrzeli znanja in harmonizirali discipline (Madni, 2007, str. 5). Med drugim tudi **ekonomija** lahko bistveno prispeva k razvoju učinkovitih TR rešitev z raziskovanjem komplementarnih pristopov, osredotočenih na kompleksne, nastajajoče in dinamične interakcije med disciplinami.

Glavni cilj TD je **razumeti ta svet** in to z uvedbo enovitega znanja ter z interakcijami med znanjem (TD Objekt) in bitjem (TD Subjekt). Z uvedbo enovitega znanja, lahko razvijemo novo TD znanje in enotno TR strategijo. TD ponuja inovativno delovno okolje, primerno za iskanje nastajajočih sistemskih rešitve za kompleksne razvojne probleme (Baumgartner, Becker, Frank, Müller & Quaas 2008, str. 387). Eden izmed ciljev TD raziskav je, da bi naravoslovni in družboslovni znanstveniki medsebojno sodelovati in s tem dosegli celovit pogled na TR področja, ki presegajo vidike posameznih disciplin (Pohl, 2005, str. 1163).

**TD pristop je mogoče implicirati na različne ravni družbene integracije.** Tako ponuja rešitve na individualni, organizacijsko-institucionalni, regionalni in državno-globalni ravni. Začetna točka (vir sprememb) se najprej zgodi na individualni ravni s sposobnostjo spreminjanja ravni zaznavanja in posledično spremembo ravni Realnosti. Na individualni ravni je vsak posameznik prepuščen samemu sebi in osebnim prepričanjem v kolikor mu ta niso vsiljena iz okolja.

- 1. **Individualna raven:** spreminjanje (diskontinuiteta) ravni zaznavanja in posledično spreminjanje (razvoj) projicirane ravni Realnosti (glej Sliko 11); TD predstavlja rešitev za krizo človeške percepcije in pomanjkanje vizije ter imaginacije v smeri TR;
- 2. **Organizacijska-institucionalna raven (mikro sfera):** TD povezovanje razdrobljenih disciplin (znanja), še posebej ko so si v konfliktu (glej Sliko 12); rezultat je novo TD znanje in nova organizacijska vizija.
- 3. **Regionalna raven:** vključevanje različnih deležnikov (ne-akademski partnerji, civilna družba) že v začetni fazi, t.j. pri določanju ciljev (glej Sliko 13), in tako reševati dejanske TR probleme s skupno TD vizijo.
- 4. **Državno-globalna raven (makro sfera):** odpiranje alternativ obstoječim politično-družbeno-ekonomskim sistemom (glej Sliko 13); rezultati so razvijajoči se vizionarni TR sistemi.

V aplikativni raziskavi (drugi del magistrskega dela) so vključeni subjekti na organizacijsko-institucionalni ravni, t.j., izobraževalne in raziskovalne organizacije. Ostale ravni družbene integracije v aplikativni raziskavi niso vključene. Iz dosedanjih analiz sem sicer ugotovil, da so rešitve TD pristopa najbolj pogoste ravno na drugi – organizacijsko-institucionalni ravni. Zaznati je tudi uporabo koncepta TD na regionalni ravni (TD regionalni razvojni projekti), medtem ko je na državno-globalni ravni prisotna uporaba v Organizaciji Združenih Narodov (OZN) še posebej v okviru DESD. Na tem nivoju je uporaba koncepta TD šele v začetni, razvijajoči se fazi.

**TD je nov način razmišljanja in razumevanja** problemov kompleksnih sistemov, saj prečka meje ločenih disciplin. Celovito in enovito znanje, ki se osredotoča bolj na pozitivizem kot na normativizem, lahko učinkovito obvladuje zapletene globalne TR probleme. Na drugi strani, redukcionistično oziroma disciplinarno znanje povzroča neuravnotežen TR s spiralo obrnjeno navzdol, ki vodi v še globlje globalne TR probleme. TD predstavlja epistemološki izziv, ki uvaja **kvantno logiko, kot nadomestilo za linearno logiko, in opusti predpostavko obstoja ene same realnosti.** (Max-Neef, 2005). Medtem ko multi-in interdisciplinarnost izhajata iz klasične fizike in klasične znanosti, TD bazira na kvantni fiziki, teoriji kaosa, teoriji živih sistemov, znanosti o zavesti, in na drugih znanostih (Nicolescu, 2010). Štirje stebri TD določajo metodologijo TD raziskav (Nicolescu, 2002): multi-ravni Realnosti, logika vključene sredine, kompleksnost in celovit sistem človeških vrednot.

Sistem v katerem živimo je potrebno videti od znotraj in od zunaj, saj ravno raznovrstnost pogledov omogoča boljše razumevanje. **Ljudje se običajno navežemo na določen konflikt in pozabimo na njegov vzrok,** t.j., kontradikcija. S tem konflikta in ne kontradikcij nismo presegli ampak obratno, poglobili smo jih v spiralo navzdol. Konflikt nastane zaradi daljšega zadrževanja na eni in isti ravni Realnosti. Zmožnost opustitve navezanosti na eno in isto raven Realnosti, e.g., na TR konflikte, je prvi pogoj za pot proti apolonskim vrednotam in celoviti obravnavi TR. »Zeleni reformizem« je tipični primer kako TR postaviti v konfliktno situacijo namesto, da bi predstavil celovit model za reševanje kontradikcij še preden pridejo v večje konflikte.

Disciplinarne raziskave večinoma upoštevajo le eno in isto raven Realnosti. Še več, v večini primerov upoštevajo le fragmente eni ravni Realnosti. V sedanjem času lahko opazimo prevlado napačnih prepričanj kot so redukcionizem, binarna logika in disciplinarnost. TD jim ne nasprotuje, ampak jim raje daje nov smisel. Določene ravni Realnosti ni mogoče razumeti z zakoni in koncepti druge ravni (van Breda, 2008). Vsaka disciplina ima sama po sebi svojo vsebino, ne pa tudi smisla. Disciplina dobi svoj smisel šele z vzpostavitvijo odnosov in razmerij z drugimi disciplinami. Kakorkoli, **dve discipline ne moreta imeti enako vsebino, lahko pa si delita skupen smisel.** TD pristop združuje različne disciplinarne vsebine s skupnim smislom in z določenim skupnim ciljem.

## **APLIKATIVNA RAZISKVA**

Namen aplikativne raziskave je najti TD institucije po vsem svetu in preveriti, ali delujejo v skladu z ustanovitvenimi načeli TD. Poudarek je na TR področju, čeprav se drugih področij znanosti ne izključuje. Temeljni cilj je izbrati institucije, ki najbolj ustrezajo definiciji TD sodelovanja, t.j. tako imenovane **»IN VIVO« institucije.** Hkrati je cilj tudi ugotoviti kateri dejavniki pomembno vplivajo na stopnjo TD integracije. V primerjavi z drugimi institucijami, **»IN VIVO« institucije predstavljajo referenčne TD institucije.** Za cilj raziskave se prav tako šteje preverba hipotez.

Aplikativna raziskava je pokazala, da je verjetnost, da bi našli **»IN VIVO« institucijo** večja kadar je institucija ustanovljena že pred letom 2000, kadar se nahaja v Evropi, je dejavna na področju TR, njen tip je **»raziskovalni center v sklopu univerze«** in je aktivna na področju raziskav in podiplomskega izobraževanja. Na drugi strani pa je največja verjetnost (100 %), da bi našli **»IN VITRO« institucijo,** ko je ekonomija edino interesno področje izmed vseh področjih TR. Očitno je, da institucije ustanovljene v zadnjem času (v zadnjih 8-ih letih) izgubljajo celovit pogled na koncept TD. Razlog je lahko v tem, da koncept **TD zlorabljajo za komercialno – marketinške namene.** Institucije v Severni Ameriki so najbolj aktivne pri integriranju ekonomije in sociosfere v ne-TR skupini (predvsem v medicini in biologiji), manj pa integrirajo vsa tri področja TR. Lahko bi trdili, da je **Evropa najuspešnejša pri prevzemanju in izvajanju koncepta TD.**

## **SKLEPNE MISLI**

**Za današnji TR management obstaja veliko področij, ki bi jih moral osvojiti,** na primer znanost o kompleksnosti, sistemsko razmišljanje, kvantna logika (kot nadomestilo za linearno logiko), aksiologija, teorija kaosa, teorija živih sistemov, sodobna filozofija, znanost o zavest, in druge prirodoslovne in družboslovne znanosti. Dandanes korporativni management ne ve, kako razviti postopke za obvladovanje kompleksnih TR problemov v realnem svetu in kako razviti trajnostno politiko in strategijo. Kakorkoli, transformacija ne predstavlja samo spremembe v pogledih na svet in v navadah razmišljanja, ampak tudi spremembe v človeških izkušnjah in v vsesplošnem bivanju na svetu.

## Appendix 15: Glossary (English)

1. **Apollonian Values** – They are divided into two value type groups. The first group – Moral values consists of traditional and societal values (democratic and social values, honesty, love, equity). The second group – Fulfillment values gather values related to personal, cultural, and spiritual growth (cognitive, cultural, self-actualizing and spiritual values, creativeness, knowledge, beauty and self-realization).
2. **Binary (Classical or Linear) Logic** – It recognizes the existence of just one level of Reality. Such logic of Aristotelian tradition underlying most of our social, economic, and political institutions is not sufficient to address majority of human situations (see also Principle of Excluded Middle).
3. **Coevolution** – It describes the evolving relationships and feedback responses typically associated with two or more interdependent systems.
4. **Collaboration** – Individuals working as a group for a common good.
5. **Common Good** – The common good as an ethical principle refers to having the social systems, institutions, and environments work for the well-being of all people.
6. **Complexity** – A vast non-linear web of interconnections that resist complete, final and accurate knowledge. Complex systems behavior is difficult to comprehend because of a multiplicity of highly interrelated elements, influence and response patterns, feedback loops, mutual causality, and uncertainties, even if the behavior of each part by itself may be fully or partially understood.
7. **Cooperation** – People assisting one another to meet a common goal.
8. **Disciplinarity** – Approach to generate knowledge through the lens of a single, specialist academic discipline.
9. **Discipline** – Disciplines are understood to be areas of academic study that are part of a larger body of learning. They are comparatively self-contained and isolated domains of learning that possess their own community of experts.
10. **Ecological Economics** – Is an academic field of study that merges ecology with standard economics. Ecological economics is a prominent example of “green reformism” which is a widespread response to the current ecological crisis. The term refers to the support for improved technology and resource efficiency combined with a commitment to the logic of capitalism.
11. **Ecological Reductionism** – The idea that the human economy is entirely governed by the same laws and forces as the rest of the ecosystem, so there is no necessity to distinguish the human economy as a subsystem of ecosystem.
12. **Ecosphere** – Refers to the Earth’s spheres, a planetary ecosystem consisting of the atmosphere, the geosphere (lithosphere), the hydrosphere, and the biosphere.
13. **Environmental Economics** – Is a branch of neoclassical economics that addresses environmental problems such as pollution, negative externalities, and valuation of nonmarket environmental services. In general, environmental economics focuses almost exclusively on efficient allocation, and

accepts the pre-analytic vision of neoclassical economics that the economic system is the whole, and not a subsystem of the global ecosystem.

14. **Epistemology** – The study of the methods of generating and validating knowledge.
15. **Feedback Loop** – The results of the effects of component A on component B are fed back directly or indirectly to A. The feedback may be via a sequence of *cause-and-effects links*.
16. **Flow of Consciousness and Flow of Information** – Flow of consciousness and information enable “uncovering” new level of Reality and thus reaching new knowledge. A flow of consciousness that coherently cuts across different levels of perception must correspond to the flow of information coherently cutting across different levels of Reality. The two flows are interrelated because they share the same zone of nonresistance. They meet in a point called Hidden Third and cross many disciplinary boundaries to create a holistic problem solution.
17. **General Systems Theory (GST)** – A major role of GST was to facilitate communication between disparate fields of interest, with a goal to provide a common language with which to discuss systemic problems.
18. **“Green Reformism”** – Is a prevalent response to environmental problems because it appears to address the crisis through technological fixes while retaining capitalism’s logic. This approach refuses to acknowledge the historical and systemic reasons for crisis, and virtually guarantees that ecological collapse will occur.
19. **Greenwashing** – This word designates Green PR (Public Relations) or green marketing which misleads consumers with the perception that a company’s policies or products are truly environmentally friendly.
20. **Hidden Third** – The flow of information (external world) and the flow of consciousness (internal world) meet in a point called Hidden Third in order to insure the coherent transmission of information and consciousness. This point is the source of Reality and perception and at the same time represents connection between external and internal world. Hidden Third is a place where its mediating mechanism makes it possible to unify knowledge necessary for developing holistic sustainable future.
21. **Holistic Approach** – Seeks the essence or core of a dynamic system or idea, while describing the full details of a system or idea.
22. **Human Values** – They could be understood as motives or motivational goals on a very high level of generality. There are two large categories of values (macrocategories), i.e., Dionysian and Apollonian macrocategories.
23. **Ignorance** – It means the deliberate avoidance of knowledge of something or the unwitting lack of knowledge for it.
24. **“IN VITRO”** – (Latin “*within glass*”) Refers to weak TD integration. “IN VITRO” institutions are usually active within a singled discipline and normally do not pay attention to TK. However, in biology it refers to studies in experimental biology that are conducted using components of an organism that have been isolated from usual biological context in order to permit a more detailed or more convenient analysis than can be done with whole organisms. In contrast to the “IN VIVO”, “IN

VITRO” is applied to processes that take place in an artificial environment outside a living being, that is, in controlled environment (e.g. laboratory, test tube).

25. **“IN VIVO”** – (Latin “*within the living*”) Corresponds to strong TD integration that takes into consideration different stakeholders, complexity, TD values, TD Subject, adopts systems thinking approach, etc. In biology, “IN VIVO” refers to experimentation using a whole, living organism as opposed to a partial or dead organism (“IN VITRO” controlled environment). “IN VIVO” testing is employed over “IN VITRO” because it is better suited for observing the overall effects of an experiment on a living subject.
26. **“IN VIVO” Institution** – There are three essential features of “IN VIVO” institutions. Firstly, all areas of interests (economy, sociosphere and ecosphere) are integrated. Secondly, they integrate different nonacademic stakeholders (civil society). Lastly, they adopt systems thinking approach and/or complexity theory and/or chaos theory and/or Apollonian values and/or TD Subject and other fundamental TD components.
27. **Integration** – Forming a unified whole from individual parts.
28. **Interdisciplinarity** – Approach resulting from the bringing together of disciplines that retain their own concepts and methods.
29. **Intergenerational Justice** – Justice between humans of different generations.
30. **Interpretive Systems Approaches** – A subjectivist approach to systems thinking, allowing multiple goals and a certain divergence of views of what the system is. But only where there is sufficient sharing of interests and goals that cooperation and compromise is possible.
31. **Intragenerational Justice** – Justice between different humans of the same generation, in particular the present generation.
32. **Isomorphism** – The belief that we can have direct, objective and value-free perceptions and knowledge of the world.
33. **Levels of Perception** – The different levels of Reality are accessible to human knowledge thanks to the existence of different levels of perception. They are found in a one-to-one correspondence with levels of Reality. Levels of perception can be activated as a consequence of different states of consciousness induced by our physical structure and our sensorial organs. Different levels of perceptions are reachable through altered states of consciousness.
34. **Levels of Reality** – It refers to a group of systems which are invariant under certain laws. Two levels of Reality are different if there is a break in the laws and a break in fundamental concepts (like, for example, causality). The existence of different levels of Reality has been affirmed by different traditions and civilizations. The discontinuity that is manifested in the quantum world is also manifested in the structure of the levels of Reality.
35. **Logic of Included Middle** – It explains how levels of Reality can be crossed according to their nature of discontinuity. Two neighbouring levels of Reality are connected by the logic of the included middle, a new logic as compared with classical logic (binary or linear logic). It provides understanding of an axiom that “there exists a third term T which is at the same time A and non-A”.

Logic of included middle can be adequate for complex conflicting situations, such as those we must confront in the educational, political, social, religious and cultural areas.

36. **Multidisciplinarity** – Two or more academic disciplines combined to focus on a particular purpose or problem, each contributing by using their own disciplinary concepts and methods. The “silos” of knowledge that result are often brought together as individual parts of a report without attempt to integrate them. There is little cross-fertilization among disciplines in the outcomes.
37. **Mutual Causality** – The perspective brings to view a world where “everything flows.” To be interdependent and reciprocally affecting is to be in the process. In this fluid state of affairs the Subject and the Object are no exception. The things and substances which make up the world have process as their nature. Similarly is the systems view of mutual causality grounded in the assumption that all is process. The universe is seen as made up not of things, but of flows (flows of consciousness and flows of information) and relationships. In such a world the Object and the Subject appear as emergent, defining and defined by interactions with the surrounding environment (rather than seen in terms of substance or isolated ultimate identity).
38. **Mutual Learning** – Refers to processes of mutual knowledge and value exchange and learning between different disciplines and between research and practice.
39. **Partiality** – The inability to include everything requires selecting certain parts or aspects over others.
40. **Participatory Research** – It implies that non-academic actors can help shape the research process. The aim of involving social groups is often primarily to integrate various life-world perspectives and interests into TD research. But beyond this, participatory research is also a means of grasping the complexity of a problem with the help of local knowledge, of testing the situational relevance and transferability of results or of finding solutions for what is perceived to be the common good. Such research improves the practice-oriented effectiveness of results.
41. **Physiocentric Ethics** – Justice between humans and nature.
42. **Plurality** – More than one view, approach, theory or ethics is possible.
43. **Principle of Excluded Middle (or Excluded Middle Logic)** – It states that for any proposition, either that proposition is true, or its negation is. It is also known as the principle of the excluded third. Latin designation for this principle is tertium non datur: “no third (possibility) is given”. The earliest known formulation is by Aristotle, where he says that of two contradictory propositions (where one proposition is the negation of the other) one must be true, and the other false. He also says that it is necessary in every case to affirm or deny, and that it is impossible that there should be anything between the two parts of a contradiction (see also Binary Logic).
44. **Problem Orientation** – Refers to the focus in TD research on concrete problems from the real world and the formulation of problem-solving strategies.
45. **Quantum Physics/Mechanics** – It is a branch of physics that deals with discrete, indivisible units of energy called quanta in order to describe and predict the properties of a physical system. Quantum principles have required fundamental changes in how humans view nature. Matter has been observed to behave very differently at the atomic level as opposed to matter in a macro world. Because of this, a completely new set of principles had to be developed that would apply to matter and energy on the

atomic level. To many philosophers, the conflict between the fundamental features of quantum mechanics and older assumptions about determinism has provided a cognitive shock that was even more unsettling than the revised views of space and time brought by relativity.

46. **Realism** – The belief in a world that exists independently of our perception of it; conventionally refers to the physical world.
47. **Reality** – That which resists our experiences, representations, descriptions, images, or even mathematical formulations. Reality is accessible to our knowledge by our observations or logical reasoning, which is subject to our perceptions and interpretations.
48. **Recursiveness** – Is a general principle of TD research. It implies that the research process has to be shaped in such a way that concepts and methods can be repeatedly tested, and that underlying assumptions can be modified if they are found to be inadequate. Recursive relationship refers back to itself (e.g. mutual causality) in an iterative sequence of evaluations.
49. **Reductionist Thinking, Reductionism** – Assumes that all phenomena or events can be reduced, decomposed, or disassembled sequentially into more and more basic elements. In terms of decision making, this implies that a problem can be broken into simpler and simpler subproblems, and the solution to the original problem can be built up from the aggregation of solutions to the subproblems.
50. **Relativism** – Our beliefs about the world, our methods of knowing, or our ethics arise from the options of individuals (or defined communities) and cannot be justified in relation to standards of others.
51. **Sociosphere** – All human beings on the planet and all their interrelationships.
52. **Sustainable Development (SD)** – Is a global socio-political model for changing practices and institutions in order to achieve more equitable opportunities within and between generations, while taking into account limitations imposed by the state of technology and the nature of social organization. It is a way to conceive the common good as the basic principle of public legislation in a complex world.
53. **System Dynamics** – Is a method for understanding the dynamic behavior of complex systems.
54. **Systems Thinking** – System elements are viewed as an interdependent part of a larger whole (a system) and *its behavior is explained by its role in that system*. This is contrast to reductionist or cause-and-effect thinking which explains system behavior by the behavior of individual components. In systems thinking, the whole is greater than the sum of its parts.
55. **Third Term** – Represents reconciliation between two contradictory (opposite) elements or phenomena, i.e., A and non-A. It provides understanding of third axiom of the included middle logic: “There exists a third term T which is at the same time A and non-A.” In this way A and non-A are at the same time preserved and also abolished. Abolished, because it represents a synthesis, i.e., a new quality. It eventually symbolizes the crossing between adjacent levels of Reality. A third term which is situated at the same level of Reality as that of the opposites A and non-A, cannot accomplish their reconciliation.
56. **TD Knowledge (TK)** – (Also “IN VIVO” knowledge) Represents the interaction term between the Subject and the Object, which cannot be reduced neither to the Object nor to the Subject. It

corresponds to a new type of knowledge – “IN VIVO” knowledge. This new knowledge is concerned with the correspondence between the external world of the Object and the internal world of the Subject. By definition, the TK includes a system of values and implies the impossibility of a self-enclosed complete knowledge. Thus TK is forever opened. It is important to realize that the DK and the TK are not antagonist but complementary.

57. **TD Object** – The unity of levels of Reality and its complementary zone of nonresistance constitute what we call the TD Object. It represents external world which in SD terms could imply fields of ecosphere (environments) and economy such as physics, biology, economics, chemistry, etc. It is composed by physical elements in the environment without paying attention to relations between them (the meaning of the elements is excluded). Dionysian values are focusing on this physical world.
58. **TD Research** – Is needed when knowledge about a societally relevant problem field is uncertain and when the concrete nature of problems is disputed. TD research deals with problem fields in such a way that it can: a) grasp the complexity of problems, b) take into account the diversity of Realities and scientific perceptions of problems, c) link abstract and case-specific knowledge, and d) develop knowledge and practices that promote what is perceived to be the common good. But when pragmatism is ignored, this leads to the discrepancy between knowledge and practice. For TD research, the challenge is to learn how to make what is established more “flexible” in order to have any chance at all of being effective. However TD research approach is based on the integration and development of new concepts, especially in cases when disciplinary concepts are contradictory. Research activities include also non-academic stakeholders and are focused on applicative results. They are derived from a goal and not from the disciplinary dichotomy.
59. **TD Research Process** – Different phases of a research project do not unfold in a linear sequence, instead they may be modified during the research process in an iterative and recursive manner based on the experience gained.
60. **TD Subject** – The unity of levels of perception and the complementary zone of nonresistance constitutes the TD Subject. It gives the meaning to the physical elements of TD Object, the meaning from individual, political, social, historical point of view. It represents human relations towards TD Object.
61. **TD Values** – They are predominantly related to Apollonian values. But, due to non-reductionistic interpretation of the concept of TD, values related to Dionysian group are not being excluded. Dionysian values can be attributed to the TD Object, while Apollonian values can be assigned to the TD Subject. Together, in a balanced proportion, both groups of values create TD values.
62. **Thermodynamics** – The branch of physics that tells us that matter and energy can be neither created nor destroyed and that entropy in the total system always increases. This branch of physics is the most relevant to economics because it helps to explain the physical roots of scarcity (see also Quantum Physics).
63. **Transdisciplinarity (TD)** – It is at the same time between the disciplines, through the various disciplines and beyond any discipline. It is an intellectual attitude which studies the phenomena by several disciplines at the same time. TD is interested in the dynamic action of different levels of Reality at the same time. While multi- and interdisciplinarity stem from classical physics and sciences, TD is based on quantum physics and chaos theory, living systems theory, consciousness

sciences and other human sciences. Among others, it is concerned by the problem of the human values while its end is the understanding of the present world.

64. **Zone of Nonresistance** – It extends the unity of levels of Reality and level of perception to our experiences, representations, descriptions, images, and mathematical formulations. In this zone there are no levels of Reality and no levels of perception. The nonresistance of this zone of absolute transparency is due to the limitations of our bodies and of our sense organs. The two zones of nonresistance of TD Object and TD Subject must be identical for the TD Subject to communicate with the TD Object. The zone of nonresistance corresponds to the sacred – to that which does not submit to any rationalization. The zone of non-resistance *plays the role of the included middle* (see also Logic of Included Middle), which allows the unification of the TD Subject and the TD Object while preserving their difference.

## Appendix 16: Glossary (Slovenian language)

Translation of the glossary in Slovene language has **the same sequence of terms** as glossary in English language.

1. **Apolonske vrednote** – Delijo se v dve skupini vrednot. Prva skupina – Moralne vrednote je sestavljena iz tradicionalnih in družbenih vrednot (demokratične in družbene vrednote, poštenost, ljubezen, pravičnost). Druga skupina – Izpolnitvene vrednote vsebuje vrednote, povezane z osebno, kulturno in duhovno rastjo (kognitivne, kulturne, samo-aktualizacije in duhovne vrednote, ustvarjalnost, znanje, lepota in samo-realizacija).
2. **Binarna (klasična ali linearna) logika** – Priznava obstoj le ene ravni Realnosti. Takšna logika ima Aristoteljevo tradicijo in predstavlja temelj za večino naših družbenih, gospodarskih in političnih ustanov. Binarna logika ne zadostuje za reševanje večino človeških situacij (glej tudi Načelo izključene sredine).
3. **Koevolucija** – Opisuje spreminjajoče se odnose in povratne odzive običajno dveh ali več soodvisnih sistemov.
4. **Sodelovanje** – Posamezniki, ki delajo kot skupina za skupno dobro.
5. **Skupno dobro** – Skupno dobro, kot etično načelo pomeni, da obstajajo socialni sistemi, institucije in okolja, ki delujejo za skupno dobro vseh ljudi.
6. **Kompleksnost** – Velika nelinearna mreža povezav, ki se upira popolnemu, končnemu in točnemu znanju. Vedenje kompleksnih sistemov je težko razumeti zaradi množice močno medsebojno povezanih elementov, vplivnih in odzivnih vzorcev, povratnih zank, vzajemne kavzalnosti in negotovosti, čeprav se lahko obnašanje vsakega posameznega dela v celoti ali delno razume.
7. **Kooperacija** – Ljudje si pomagajo drug drugemu, da izpolnijo skupni cilj.
8. **Disciplinarnost** – Pristop za pridobivanje znanja skozi objektiv enotne, specializirane akademske discipline.
9. **Disciplina** – Discipline razumemo kot področja akademskih študij, ki pripadajo večji skupini znanstvenih strok. So razmeroma samozadostna in izolirana področja ter razpolagajo z lastno skupnostjo strokovnjakov.
10. **Ekonomika ekologije** – Je akademsko področje, ki združuje ekologijo s standardno ekonomijo. Ekonomika ekologije je izrazit primer »zelenega reformizma«, ki predstavlja razširjen odziv na sedanjo ekološko krizo. Termin se nanaša na podporo za izboljšano tehnologijo in učinkovitost virov v kombinaciji z zavezanostjo logiki kapitalizma.
11. **Ekološki redukcionizem** – Ideja, da človeško gospodarstvo v celoti deluje z enakimi zakoni in silami kot deluje ekosistem, tako da ni potrebno razlikovati gospodarstva kot podsistema ekosistema.
12. **Ekosfera** – Nanaša se na različne sfere Zemlje, torej na planetarni ekosistem, ki ga sestavljajo atmosfera, geosfere (litosfere), hidrosfere, in biosfere.
13. **Ekonomika okolja** – Je veja neoklasicistične ekonomije, ki obravnava okoljske probleme, kot so onesnaževanje, negativne eksternalije ter vrednotenje netržnih okoljskih storitev. Na splošno velja, da

se ekonomika okolja osredotoča skoraj izključno na učinkovito razporejanje resursov in pri tem sprejema pred-analitično vizijo neoklasicistične ekonomije, da je gospodarski sistem celota, in ne podsistem globalnega ekosistema.

14. **Epistemologija** – Proučevanje različnih metod ustvarjanja in preverjanja znanja.
15. **Povratna zanka** – Rezultati učinkov vpliva elementa A na element B se kažejo neposredno ali posredno nazaj na element A. Povratna zanka se lahko odvija preko zaporedja povezav med vzroki in učinki.
16. **Tok zavesti in tok informacij** – Tok zavesti in informacij omogočata »spoznavanje« novih ravni Realnosti in s tem doseganje novega znanja. Tok zavesti, ki usklajeno prehaja skozi različne ravni zaznavanja mora ustrezati pretoku informacij, ki usklajeno prehaja skozi različne ravni Realnosti. Oba tokovi sta med seboj povezana, saj delita isto »območje brez odpora«. Tokova se srečujeta v t.i. točki »skritega tretjega« in prečkata številne disciplinarne meje, da bi se kreirale celostne rešitve problema.
17. **Splošna teorija sistemov (GST)** – Glavna vloga GST je bila olajšati komunikacijo med nezdružljivimi interesnimi področji, s ciljem zagotoviti skupen jezik, s katerim bi lahko razpravljali sistemske težave.
18. **»Zeleni reformizem«** – Je prevladujoč odziv na okoljske probleme, saj se pri reševanju krize obrača na tehnološke popravke pri čemer pa ohranja logiko kapitalizma. Ta pristop ne želi priznati zgodovinskih in sistemskih vzrokov za krizo in dejansko zagotavlja, da bo ekološki kolaps še toliko bolj mogoč.
19. **»Zeleno pranje možganov«** – Ta beseda označuje zeleni PR (odnosi z javnostmi) ali zeleni marketing, ki zavaja potrošnike z mnenjem, da so strategije podjetje oz. izdelki in storitve resnično okolju prijazni.
20. **»Točka skritega tretjega«** – Pretok informacij (zunanji svet) in pretok zavesti (notranji svet) se srečata v t.i. točki »skritega tretjega«, tako da se zagotovi skladen prenos informacij in zavesti. Ta točka je vir Realnosti in zaznavanja in hkrati predstavlja povezavo med zunanjim in notranjim svetom. »Skriti tretji« je kraj, kjer njen posredovalni mehanizem omogoča, da se znanje, ki je, potrebno za razvoj celovite trajnostne prihodnost, poenoti.
21. **Celovit pristop** – Išče bistvo ali osrednji del dinamičnega sistema ali pa idejo, ki opisuje vse podrobnosti o sistemu.
22. **Vrednote** – Lahko jih razumemo kot motive ali motivacijske cilje na zelo visoki ravni splošnosti. Obstajata dve veliki skupini vrednot (makrokategorije), tj. dionizična in apolonska makrokategorija.
23. **Ignoranca** – To pomeni namerno izogibanje znanju nečesa ali nehoteno pomanjkanje znanja za to.
24. **»IN VITRO«** – (Latinsko »znotraj kozarca«) Se nanaša na šibke TD integracije. »IN VITRO« institucije so običajno aktivne znotraj ene same discipline in običajno ne namenjajo pozornosti TD znanju. V eksperimentalni biologiji se termin nanaša na študije, ki se izvajajo s posameznimi delih organizma, ki so bili izolirani od običajnega biološkega konteksta z namenom, da bi omogočili podrobnejšo oz. bolj pripravno analizo, kot bi to bilo mogoče storiti z celim organizmom. Za razliko

od »IN VIVO«, se termin »IN VITRO« uporablja za procese, ki se izvajajo v umetnem okolju izven živega bitja, tj. v nadzorovanem okolju (npr. v laboratoriju, v epruveti).

25. **»IN VIVO«** – (Latinsko »*znotraj življenja*«) Termin se nanaša na močne TD integracije, ki upoštevajo različne interesne skupine, kompleksnost, TD vrednote, TD Subjekt, sprejemajo pristop sistemskega razmišljanja, itd. V eksperimentalni biologiji, se termin »IN VIVO« nanaša na eksperimentalne poskuse s celim, živim organizmom, v nasprotju z delnim ali mrtvim organizmom (»IN VITRO« nadzorovano okolje). »IN VIVO« eksperimenti se pogosteje uporabljajo kot »IN VITRO«, saj so bolj primerni za opazovanje skupnih učinkov eksperimenta na živ organizem.
26. **»IN VIVO« institucije** – Obstajajo tri bistvene značilnosti »IN VIVO« institucij. Prvič, vsa področja interesov (ekonomija, sociosfera in ekosfera) so integrirana. Drugič, vključujejo različne neakademske interesne skupine. Nazadnje, privzemajo pristop sistemskega razmišljanja in/ali teorijo kompleksnosti in/ali teorijo kaosa in/ali apolonske vrednote in/ali TD Subjekt in druge temeljne TD sestavne komponente.
27. **Integracija** – Oblikovanje povezane enovite celote iz posameznih delov.
28. **Interdisciplinarnost** – Pristop, ki izhaja iz povezovanja disciplin medtem, ko istočasno ohranjajo svoje koncepte in metode.
29. **Medgeneracijska pravičnost** – Pravičnost med ljudmi različnih generacij.
30. **Interpretativni sistemski pristopi** – Subjektivističnih pristop sistemskemu razmišljanju, ki dopušča več ciljev in določene razlike v pogledih o tem, kaj sistem je. Vendar le v primeru, ko obstaja dovolj izmenjav interesov in ciljev tako, da sta kooperacija in kompromis mogoča.
31. **Znotrajgeneracijska pravičnost** – Pravičnost med različnimi ljudmi iz iste generacije, zlasti sedanje generacije.
32. **Izomorfizem** – Prepričanje, da imamo lahko neposredne, objektivne zaznave in znanja o svetu, ki so brez vrednot.
33. **Ravni zaznavanja** – Različne ravni Realnosti so dostopne človeškemu znanju zahvaljujoč obstoju različnih ravni zaznavanja. Te se natančno ujemajo (ena-na-ena) z ravnmi Realnosti. Ravni zaznavanja se lahko aktivirajo kot posledica različnih stanj zavesti, ki jih povzročajo naše fizične strukture in naši zaznavni organi. Različne ravni zaznavanja so dosegljive s spremembo stanja zavesti.
34. **Ravni Realnosti** – Nanaša se na skupino sistemov, ki so nespremenljivi pod določenimi zakoni. Dve ravni Realnosti sta različni, če obstaja nezveznost v zakonih in nezveznost v temeljnih konceptih (kot so, na primer, kavzalnost). Obstoj različnih ravni Realnosti je bil potrjen s strani različnih tradicij in civilizacij. Nezveznost, ki se manifestira v kvantnem svetu se manifestira tudi v strukturi ravni Realnosti.
35. **Logika vključene sredine** – Pojasnjuje, kako se lahko ravni Realnosti prečka glede na njihovo nezvezno naravo. Dve sosednji ravni Realnosti sta povezani z logiko vključene sredine, novo logiko v primerjavi s klasično logiko (binarno ali linearno logiko). Nova logika nudi razumevanje naslednjega aksioma: »obstaja tretji izraz T, ki je hkrati A in ne-A«. Logika vključene sredine je primerna za

kompleksne konfliktna situacije, kot so tiste s katerimi se moramo soočiti v izobraževalnih, političnih, socialnih, verskih in kulturnih področjih.

36. **Multidisciplinarnost** – Dve ali več akademskih disciplin so skupaj osredotočene na določen namen oz. problem s tem, ko vsaka disciplina prispeva svoje disciplinarne koncepte in metode. Rezultat aktivnosti je »silos« znanja, ki vključuje posamezne nepovezane dele. V končnih rezultatih je malo vzajemnega disciplinarnega bogatenja.
37. **Vzajemna kavzalnost** – Ta vidik ustvarja pogled na svet, v katerem »vse teče«. Biti soodvisen in vzajemno vpliven pomeni biti v procesu. V tem tekočem stanju Subjekt in Objekt nista nobene izjeme. Stvari in snovi, ki sestavljajo ta svet imajo proces za svojo naravo. Podobno velja za sistemski pogled na vzajemno kavzalnost, ki temelji na predpostavki, da je vse proces. Videti je, da univerzum ni sestavljen iz stvari, ampak iz tokov (tok zavesti in tok informacij) in odnosov. V takem svetu se Objekt in Subjekt pojavljata kot nastajajoča, opredeljujoča in določena z interakcijami z okoljem, ki ju obdaja (namesto, da bi bila vidna kot snov ali izolirana končna identiteta).
38. **Vzajemno učenje** – Nanaša se na procese vzajemne izmenjave znanj in vrednot in na učenje med različnimi disciplinami in med raziskovalno sfero ter prakso.
39. **Pristranost** – Nezmožnost vključitve vsega zahteva izbor določenih delov ali aspektov pred ostalimi.
40. **Participativno raziskovanje** – To pomeni, da lahko ne-akademski akterji pomagajo oblikovati raziskovalni proces. Namen vključevanja družbenih skupin je predvsem v povezovanju različnih stvarnih pogledov in interesov v TD raziskave. Poleg tega, participativno raziskovanje predstavlja tudi način razumevanja kompleksnosti problema s pomočjo lokalnega znanja, testiranja situacijskih pomembnosti in prenosljivosti rezultatov, ali iskanja rešitev za to, kar je zaznano kot skupno dobro. Takšno raziskovanje izboljšuje praktično usmerjenost in učinkovitost rezultatov.
41. **Fiziocentrična etika** – Pravičnost med ljudmi in naravo.
42. **Pluralnost** – Več kot le en pogled, pristop, teorija ali etika je mogoč.
43. **Načelo izključene sredine (ali logika izključene sredine)** – Za vsako trditev je možno, da je bodisi resnična, ali pa je resnična njena negacija. Načelo je prav tako znano kot načelo izključene tretje točke. Latinsko poimenovanje za to načela je tertium non datur: »nobena tretja (možnost) ni dana«. Najstarejša znana formulacija je Aristoteljeva, ki pravi, da je od dveh nasprotujočih si trditev (kjer je ena trditev negacija druge) ena resnična, in druga napačna. Prav tako pravi, da je potrebno v vsakem primeru potrditi ali zanikati trditev, in da je nemogoče, da bi bilo karkoli med obema deloma kontradikcije (glej tudi binarna logika).
44. **Osredotočenost na problem** – Se nanaša na osredotočenost TD raziskav na konkretne probleme iz realnega sveta in na oblikovanje strategij reševanja takih problemov.
45. **Kvantna fizika/mehanika** – Je veja fizike, ki se ukvarja z diskretnimi, nedeljivimi enotami energije t.i. kvanti, da bi opisala in napovedala lastnosti fizičnega sistema. Kvantna načela so zahtevala temeljne spremembe v pogledih ljudi na naravo. Ugotovljeno je bilo, da se materija obnašajo zelo drugače na atomski ravni, v primerjavi z materijo v makro svetu. Zato je bilo potrebno razviti povsem nov sklop načel, ki bi se uporabljala za proučevanje materije in energije na atomski-mikro ravni. Veliko filozofov meni, da je konflikt med temeljnimi načeli kvantne mehanike in

starejšimi predpostavkami o determinizmu povzročil kognitiven šok. Ta je bil še toliko bolj vznemirljiv kot je bilo to v primeru spremenjenih stališč do prostora in časa, ki jih je povzročila relativistična teorija.

46. **Realizem** – Prepričanje v svet, ki obstaja neodvisno od našega zaznavanja tega sveta; običajno se nanaša na fizični svet.
47. **Realnost** – Kar se upira našim izkušnjam, predstavam, opisom, slikam, ali celo matematičnim formulacijam. Realnost je dostopna našemu znanju preko naših opazovanj ali logičnega sklepanja, ki je predmet našim zaznavam in interpretacijam.
48. **Rekurzivnost** – Je splošno načelo TD raziskav. To pomeni, da mora biti raziskovalni proces oblikovan na ta način, da so koncepti in metode večkrat preizkušeni, in da so lahko temeljne predpostavke spremenjene, če se izkažejo za nezadostne. Rekurziven odnos se sklicuje nazaj na samega sebe (npr. vzajemna kavzalnost) v ponavljajočim zaporedju ocen.
49. **Redukcionistično mišljenje, redukcionizem** – Predpostavlja, da so lahko vsi pojav ali dogodki reducirani, razčlenjeni, ali razstavljeni zaporedno na vse bolj in bolj osnovne elemente. V smislu odločanja, to pomeni, da je mogoče določen problem razdeliti na enostavnejše in enostavnejše podprobleme. Rešitev prvotnega problema pa je mogoče zgraditi iz seštevka rešitev za posamezne podprobleme.
50. **Relativizem** – Naša prepričanja o svetu, naše metode vednosti, ali naše etike izhajajo iz možnosti posameznikov (ali določene skupnosti) in jih ni mogoče upravičiti v zvezi s standardi drugih.
51. **Sociosfera** – Vsi ljudje na planetu in vsi njihovi medsebojni odnosi in razmerja.
52. **Trajnostni razvoj (SD)** – Je globalni družbeno-politični model za spreminjanje praks in institucij, da bi dosegli bolj pravične možnosti znotraj in med generacijami, ob upoštevanju omejitev s strani različnih zmožnosti tehnologij in specifične narave družbenih organizacij. To je način razumevanja skupnega dobrega, kot osnovnega načela zakonodaje v kompleksnem svetu.
53. **Dinamika sistema** – Je metoda za razumevanje dinamičnega obnašanja kompleksnih sistemov.
54. **Sistemsko razmišljanje** – Sistemski elementi se obravnavajo kot soodvisen del večje celote (sistema) in njegovo obnašanje je mogoče razložiti z njegovo vlogo v tem sistemu. To je nasprotno redukcionističnemu ali vzročno-posledičnemu mišljenju, ki pojasnjuje obnašanje sistema z obnašanjem posameznih komponent. Pri sistemskem razmišljanju je celo večja kot pa vsota njenih delov.
55. **Tretji člen** – Predstavlja spravo med dvema kontradiktornima (nasprotujočima si) elementoma ali pojavoma, t.j. A in ne-A. Zagotavlja razumevanje tretjega aksioma logike vključene sredine: »Obstaja tretji člen T, ki je hkrati A in ne-A.« Na ta način sta A in ne-A hkrati ukinjena in ohranjena. Ukinjena zato, ker sinteza predstavlja nekaj novega, t.j. novo kvaliteto. Eventualno, simbolizira prehod med sosednjimi ravni Realnosti. Tretji člen, ki se nahaja na isti ravni Realnosti kot nasprotja A in ne-A, ne more doseči njune sprave.
56. **TD znanje (TK)** – (Tudi »IN VIVO« znanje) Predstavlja pojem interakcije med Subjektom in Objektivom, ki se ne more reducirati niti na Objekt niti na Subjekt. Ustreza novemu tipu znanju t.i. »IN VIVO« znanju. To novo znanje se ukvarja z odnosom in razmerjem med zunanjim svetom Objekta in

notranjim svetom Subjekta. Po definiciji, TD znanje vključuje sistem vrednot in implicira nezmožnost samo-zaprtega končnega znanja. Tako je TD znanje za vedno odprto. Pomembno se je zavedati, da disciplinarno znanje in TD znanje nista antagonistična, ampak dopolnjujoča.

57. **TD Objekt** – Enotnost ravni Realnosti in njeno komplementarno »območje brez odpora« predstavlja tisto, kar imenujemo TD Objekt. Predstavlja zunanji svet, ki v kontekstu SD pomeni področja ekosfere (okolja) in ekonomije, kot so fizika, biologija, gospodarstvo, kemija itd. Sestavljen je iz fizičnih elementov v okolju, ne da bi vključeval odnose in razmerja med njimi (smisel elementov ni vključen). Dionizične vrednote so osredotočene na ta fizični svet.
58. **TD raziskovanje** – Se uporablja, ko je znanje o družbeno pomembnem problemskem področju negotovo in kadar je narava problemov sporna. TD raziskave obravnavajo problemska področja na način, da lahko: a) zaznajo kompleksnost problemov, b) upoštevajo raznolikost Realnosti in znanstvenih zaznav problemov, c) povezujejo abstraktna in problemsko-specifična znanja, in d) razvijajo znanja in prakse, ki spodbujajo, kar je zaznano kot skupno dobro. Toda, ko se ignorira pragmatizem, to privede do neskladja med znanjem in prakso. Za TD raziskave je izziv naučiti se, kako narediti tisto, kar je že vzpostavljeno bolj »fleksibilno«, da bi imeli sploh kakšno možnost za učinkovitost. Kakorkoli, TD raziskovalni pristop temelji na povezovanju in razvijanju novih konceptov, predvsem v primerih, ko so si disciplinarni koncepti kontradiktorni. Raziskovalne aktivnosti vključujejo tudi ne-akademske interesne skupine in so usmerjenost k aplikativnim rezultatom. Izhajajo iz cilja in ne iz disciplinarne dihotomije.
59. **TD raziskovalni proces** – Različne faze raziskovalnega projekta ne potekajo v linearnem zaporedju. Namesto tega se lahko faze med samim raziskovalnim procesom na iterativni in rekurzivni način spreminjajo in to glede na pridobljene izkušnje.
60. **TD Subjekt** – Enotnost ravni zaznavanja in njegovo komplementarno »območje brez odpora« predstavlja tisto, kar imenujemo TD Subjekt. Ta daje smisel fizičnim elementom TD Objekta, to se pravi smisel iz individualnega, političnega, družbenega, zgodovinskega vidika. Predstavlja človeške odnose v razmerju do TD Objekta.
61. **TD vrednote** – V veliki meri se nanašajo na apolonske vrednote. Vendar, glede na neredukcionistično interpretacijo TD koncepta, ta ne izključuje vrednote, ki so del dionizične skupine vrednot. Dionizične vrednote lahko pripišemo TD Objektu, medtem ko lahko apolonske vrednote pripišemo TD Subjektu. Skupaj, v uravnoteženem razmerju, obe skupini kreirata TD vrednote.
62. **Termodinamika** – Veja fizike, ki nam pove, da se materija in energija ne morata niti ustvariti niti uničiti in da se entropija v celotnem sistemu vedno povečuje. Ta veja fizike je najbolj pomembno za ekonomijo, ker pomaga razložiti fizične osnove pomanjkanja virov (glej tudi kvantna fizika).
63. **Transdisciplinarnost (TD)** – Je hkrati med disciplinami, prek različnih disciplin in onstran vsaki disciplini. TD je intelektualno stališče, ki preučuje pojave s pomočjo večih disciplin hkrati. TD se zanima za dinamično delovanje različnih ravni Realnosti hkrati. Medtem ko multi- in interdisciplinarnost izhajata iz klasične fizike in znanosti, je TD osnovana na podlagi kvantne fizike in teorije kaosa, systemske teorije, znanosti o zavesti in na osnovi drugih družbenih znanosti. Med drugim, se zanima za problem človeških vrednot, medtem ko je njen osnovni namen razumevanje tega sveta.
64. **Območje brez odpora** – Podaljšuje enotnost ravni Realnosti in ravni zaznavanja z našimi izkušnjami, predstavami, opisi, slikami in matematičnimi formulacijami. V tem območju ni ravni

Realnosti in ni ravni zaznavanja. Brez-odpornost tega območja absolutne prozornosti je posledica omejitev naših teles in naših čutil. Oba »območja brez odpora« TD Objekta in TD Subjekta morata biti identična tako, da lahko TD Subjekt komunicira s TD Objektom. »Območje brez odpora« ustreza svetemu – tistemu, ki ni podrejen vsakršni racionalizaciji. »Območje brez odpora« igra vlogo »vključene sredine« (glej tudi Logika vključene sredine), ki omogoča poenotenje TD Subjekta in TD Objekta, hkrati pa ohranja njune razlike.