From epistemic monoculture to cooperation between epistemic communities – lessons learnt from development research

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Introduction

Science is currently confronted by a paradoxical situation. On the one hand, scientific research and its applications are being held partially responsible for a range of ecological, social and economic problems. On the other hand, science is still seen as holding out hope for solutions to these problems. The role of the sciences has thus become permanently established as a topic of social debate. Even previously "objective" scientific disciplines such as physics, chemistry and biology are now increasingly subjected to criticism. The normative and usually implicit aspects of the sciences, and hence their epistemological foundations as well, are a particular point of controversy. This controversy has since pervaded virtually all important areas of human life. Whether in medicine (allopathic versus alternative medicine), agriculture (GMOs versus organic farming), economics (liberalisation versus social regulation), or the connections between the sciences and indigenous forms of knowledge, social actors now actively take part in normative debates.

Social criticism of scientific undertakings is becoming more comprehensive, no longer focusing only on external processes of instrumentalisation of science and technology by political, economic or military elites. The internal structures of academic knowledge production are also increasingly becoming the focus of doubt. Questions about the social relevance of systematic thinking grounded in reductionism and causality to the solution of current social problems, or about the insufficient capacity to integrate scientific models rooted in an incalculable number of special disciplines, are now a permanent part of social debate.

A growing number of people are only prepared to accept scientific approaches if the ethical consequences associated with them are perceived as tolerable or desirable. Science has accordingly lost its predominant role in defining and implementing "development" or "progress" and must now be reoriented. In this regard, science is beginning to perceive its work as part of the social process, in which scientific expertise is still sought but normative implications are seen as only one among many options. Building bridges to promote better understanding between the scientific community and other social groups is accordingly seen as one of the central challenges of the 21st century.

Better mutual understanding between science and society cannot be reduced to a problem of communication, as superficially suggested in some circles. The present paper argues that lost faith in science can only be restored if the sciences are more clear about their own epistemological foundations and the values that underpin them, and are willing to see these aspects become the subject of social debate and develop them further on this basis.

The possible implications of a debate on the epistemological foundations of science are explored in what follows. Four basic elements of the sustainability debate related to the concepts of transdisciplinarity, social learning processes, indigenous knowledge and epistemology are analysed in an intercultural perspective. This allows to conclude that a post-materialist understanding of science could contribute significantly to explore new

dimensions for the integration of natural and social sciences on the one hand. On the other hand would allow to reduce the gap between such a reformed understanding of science and indigenous or local forms of knowledge. The authors draw upon experience and reflections derived from many years of international research and consulting at the Centre for Development and Environment (CDE) to promote sustainable development in Europe, Asia, Africa and Latin America.

Step1: Understanding sustainable development as a socital learning process

Nearly twenty years of efforts to make development aim for 'sustainability' have shown that 'sustainable development' does not simply consists of new knowledge and new technologies. Sustainability is generally defined as a development path aiming to fulfil the needs of present and future generations while taking into account the ecological, social and economic spheres of life and their interrelations (WCED - World Commission on Environment and Development, 1987). A major difficulty in achieving higher levels of sustainability is the entirely normative character of the concept: it defines *what* should be done without saying *how* to do it in specific social, ecological, economic and historical situations. In order to make the concept operative it must be translated into a set of new action-guiding ethical values by individuals and groups (Wiesmann, 1998).

In spite of this difficulty, the concept of sustainable development has been attractive and relevant enough to be globally acknowledged and become the conceptual foundation for the 'Agenda 21', agreed on at the Rio United Nations Conference on Environment and Development (UNCED) in 1992. The concept of sustainability was developed well before the Rio conference, but its acceptance at the international policy level represents a major paradigmatic shift in the understanding of development. In addition to recognising the need to re-conceptualise the relation between ecological, economic and social aspects, it was the first time that a broad and globally interacting coalition of governments and representatives of international civil society agreed on concrete action-guiding principles and values on which to base their increasingly complex and interdependent relationships. The importance of science in contributing to pursue the goal of more sustainable development was confirmed, under the condition that its role and relationship to society be submitted to critical examination. In Agenda 21, chapter 35 establishes that current research should be broadened to include, on the one hand, more involvement of the public in defining long-term societal goals and formulating sustainable development scenarios, and on the other to develop methods for linking the findings of established sciences with indigenous knowledges.[1]

An important step in re-conceptualising the relation between science and society was made by Funtowicz and Ravetz, who proposed a typology of forms of science according to different levels of uncertainty, complexity, and decision stakes (Funtowitz and Ravetz, 1993). The authors argued that with increasing levels of uncertainty, complexity, and decision stakes, a gradual shift from applied, 'mission-oriented' science to professional, 'client-serving' consultancy, and from there to 'issue-driven' 'post-normal science' is required. Post-normal science thus confronts epistemological and ethical uncertainties related to the need to take into account decision-making issues when the object of analysis severely affects various social actors' important interests, e.g. as is the case with climate change, biodiversity loss, and risks related to rapidly disseminating technologies such as genetically modified organisms.

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[1] http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter35.htm

In the meantime the impulses given by post-normal science deriving from policy research have been further developed and integrated into the growing field of transdisciplinary research. The challenge of re-conceptualising the relation between science and society found its most immediate echo in the development of 'transdisciplinarity', which stresses the need to project scientific knowledge production beyond its disciplines. One of its advocates, Nicolescu (1996), argues that transdisciplinarity concerns everything that is between, across and beyond disciplines, as the prefix 'trans-' indicates.

This view of science and its relation to society is the logical concretisation of a fundamental fact not sufficiently taken into account by the scientific community until the 1960s: although science – usually defining itself as an autonomous, value-free body – has been very successful as such, it has always been – and will always be – part and parcel of the 'social processes'[2] that bring actors, institutions and nature into specific, culturally shaped and historically evolving relations (Norgaard, 1994). Transdisciplinarity takes into account that science is part of the processes it describes and is therefore involved in the social dynamics that shape the world. It also recognises the plurality of forms of knowledge, world views and the ethical values connected to them within different social and cultural groups (Scholz et al., 2000). A major challenge for transdisciplinarity therefore consists in finding ways of encouraging a dialogue and cooperation between heterogeneous groups of social actors with different forms of knowledge, instead of imposing a single, thoroughly coherent view of the world through a hegemonic discourse that silences all other discourses, and positions itself outside the object of analysis.

Expanding upon the principles of transdisciplinary, partner-oriented development research elaborated by Hurni et al (2001), the transdisciplinary approach can be characterised as follows:

1. The starting points are issues of social, ecological or cultural relevance that arise from the contemporary challenges of sustainable development. Planning, execution, evaluation and interpretation of results are understood as an integral communication process that is part of a multi-stakeholder dialogue. This allows for participation of the social actors concerned – who are not necessarily bound to the scientific worldview – as representatives of equally viable forms of knowledge. Participation in the development and expansion of social platforms where such multi-stakeholder dialogue can take place is hence a part of methodological procedure.
2. With respect to academic knowledge production, the transdisciplinary approach is based on attempts at interdisciplinary bridge-building between different individual disciplines in the natural, economic, social and human sciences.
3. Scientific work is understood as part of an overall social learning process. Society and science together must determine the course of the development process as part of a social learning process; development cannot be dominated by a purely scientific agenda. Development is the result of social negotiation that must systematically take account of a plurality of worldviews and ethical codes, in a spirit of solidarity. The fundamental issue here is the connections between values (see steps 2-5 below) that grow out of the knowledge gained from daily existence and values that have academic origins.

[2] 'Social processes' are qualitative and/or quantitative changes in interaction schemes occurring between individuals and/or groups. Social processes can be triggers or conditions for general transformations in a society in the medium and long term. Social processes cannot be planned, because they are considered to be the dynamic results of planned intervention (e.g. of a development project) and the specific reactions this produces in a wider social environment (Long, 1992).

When applying a transdisciplinary approach to development research, one should take into account that societal values attributing meaning to science-based information are deeply rooted in social groups' very diverse 'life worlds'[3]. These characterise a wide variety of cultures and sub-cultures. Where scientific knowledge imposes its own values and interpretation on these life worlds, public and private distrust in scientific expertise grows and the critique formulated by developing countries of Western science's hegemonic claims increases. Those adhering to a specific life world are not interested in knowing whether it is in accordance with scientific knowledge. The problem for them is to find out whether scientific knowledge and its technological applications fulfils their needs and aspirations or harms them.

Thus, science also needs to question the institutional relationships between research, policy making and society. Underlying to present models of policy and decision-making we often find the assumption that a negotiation approach, based on the 'pursue of self-interest' which recognises other actors as competitors would be the best option for addressing problems and conflicts rising from the processes of development (Leeuwis, 2000).

However most proponents of participatory approaches to planning, decision making conceive development as a social learning process and emphasise that 'strategic reasoning' in the sense of Habermas (1988) which is similar to a self-interest driven negotiation approach is part of the problem and not the solution, since it is (unwittingly) based on unequal power relationships and perpetuates them. Consequently, participative approaches to development are oriented towards Habermas's 'communicative reasoning', which aims for agreements and consensus achieved through deliberation. This requires shared views of situations, potentials, problems and strategies for action that stress cooperation rather than competition. The extent to what this goal can be achieved does not mean to adopt a voluntaristic position because the theory of communicative reasoning acknowledges the importance of ideal speech conditions which are closely related to the social structures in which actors are embedded.

In view of the above, and against the background of the principles given by the sustainability approach – which aims to reshape the relation between society, ecology and economy, taking into account the needs of present and future generations – two conclusions can be drawn. First, the development of more sustainable societies has an epistemological dimension which is the basis for a two-part ethical determination concerning human beings and the relations between them ('society') on the one hand, and the relationship between society and nature on the other. Second, limiting institutional development to strategic reasoning and negotiation guided exclusively by the self-interests of actors involved would be too simplistic, especially when one takes into account that sustainability also requires considering the needs of future generations which because of their physical and social absence cannot be representing nor their self-interests in the negotiation process.

The search for greater sustainability therefore calls for institutional innovations and transformations, both within the scientific community and in general. What is needed is a social process through which societies *learn* how to achieve (temporary) consensus about new ways of shaping the relationship between human beings and nature. The collective and institutional dimensions of this form of development constitute the main focus of Woodhill and Röling's (2000) 'social learning approach', which is guided by a philosophy focusing on participatory processes of social change. The social learning approach is based on an actor-oriented approach and forms part of a theoretical framework in which social

[3] "The world of shared social meanings in which actors live and interact." (Tony Bilton et al., *Introductory Sociology*, 3rd edition. London, Macmillan, 1996:663; based on Alfred Schütz)

processes are defined as non-linear and non-deterministic. Development is therefore conceived of as an 'emergent quality', which goes beyond the paradigm of 'planned intervention' (Long, 2001).

The paramount role of values and the epistemological dimensions connected to them places ethical questions at the core of the social learning agenda. It is important to highlight that connecting ethical issues to the concept of social learning processes in concrete contexts means to go beyond a disciplinary-bound understanding of philosophy and ethics. Instead of relying on categories defined by the discipline of philosophy, the challenge is to find ways of contributing to social processes that allow to move towards the construction of *common* normative ground. Such a basis can be shared by a high diversity of social actors representing numerous ethical systems and combinations of them, which philosophy normally describes separately.

In the following sections we outline further steps that should be considered to achieve a shift from a science-based mode of knowledge production towards a more societal one. This move is understood as a social learning process that aims at defining strategies and measures for addressing sustainability in concrete social and natural environments. The emphasis is placed mainly on the challenges that need to be met by the scientific community, but examples from indigenous, non-scientific communities are given as well.

Step 2: Defining the relationship between scientific and 'local' forms of knowledge

As pointed out above, finding ways of interrelating scientific and local knowledge – or applying a transdisciplinary approach to knowledge production – is a key challenge for social learning processes oriented towards sustainability. Before assessing the way in which different forms of knowledge could be interrelated it is helpful to analyse the way in which science relates to other, non-scientific forms of knowledge.

The debate in science about its relation to local knowledge is not new: since the beginning of the Enlightenment, the natural sciences have always understood their role as consciously and critically revising 'local knowledge', often considered superstitious or romantic. It is therefore not surprising that the relation between science and other forms of knowledge is often reduced to an evaluation of the coherence and consistency between the two forms of knowledge in question, with science making a hegemonic claim to truth.

Today there is a growing consensus that any form of knowledge – including the natural sciences – is the result of a social construction. Eder (1996) points out that 'nature' is a social construct determined by a process that takes place at three levels: cognitive, moral and symbolic. In this perspective, 'nature' is only a specific 'signifier', while the 'signified'[4] in the description of nature is society itself. It is therefore not surprising that science has many possible ways of relating to local forms of knowledge. Table 1 summarises some of the most common relationships.

The typology reveals three major issues that need to be addressed when analysing the relationship between different forms of knowledge:

First, an intercultural perspective means to recognise that – due to global interdependence and communication – almost any type of knowledge available today is, in one way or another, influenced by others. This makes it almost impossible to distinguish between fundamental differences characterizing different 'knowledge systems'. Indeed, the notion of a 'system' implies that boundaries separating an internal from an external sphere can be

[4] Eder relies on Ferdinand de Saussure's structuralist understanding of language, meaning and reality.

defined, and distinctive structures detected. If one takes into account that few – if any – social actors rely exclusively on only one system of knowledge, the limitations of defining separate knowledges becomes even more obvious.

To overcome the conceptual limitation of conceiving of knowledges as separate systems, it is therefore advisable to describe them as 'forms' rather than 'systems'. *Forms* of knowledge are much more open to capturing the different types and possible combinations of knowledge involved in social action. Emphasising forms of knowledge means to focus on processes of knowledge creation rather than on a classification of their outcomes. This is particularly helpful in the case of local knowledges, since these forms of knowledge are related to other sources and processes than those of science, which are essentially based on rationalist critical examination. Local forms of knowledge are often related to tacit knowledge (Polanyi, 1983), and may be based on meditation, intuition, inspiration and empathy (Millar, 1996). They may also be inaccessible to non-initiates (secret knowledges), a limitation that poses a very special ethical problem that requires separate treatment which goes beyond the scope of this paper.

Second, the comparison between the different attitudes reveals how strongly the relation between science and local knowledge depends on specific ethical positions. No relation between science and local knowledge is value free. Moreover, since knowledge production occurs within specific contexts, it is also always inflected by specific power relations that determine who produces knowledge, who transmits it, who has access to it, and what purpose the knowledge is meant to serve.

Table 1: Typology of science's relations to local forms of knowledge

Attitude of science towards local knowledge	Characteristics	Examples
Unacknowledging	Science simply ignores a practice based on local knowledge.	Veterinary research does not investigate the effects of a ritual to prevent mouth and foot disease in the Andes.
Utilitarian	Elements of local knowledge that can be scientifically understood or validated are accepted to increase the stock of scientific knowledge.	Aspirin is based on a local practice developed in Antiquity by the Egyptians (using dried myrtle leaves) and the Greeks (with willow bark), who did not know its active ingredient (salicylic acid).
Paternalistic	Traditional knowledge is conceived of as a starting point that requires 'updating' by science.	Indigenous field crops are modified through genetic engineering and traditional livestock breeding is 'blended' with 'modern' technologies.
Essentialist	Local knowledge is fundamentally better than science, it should not be influenced by Western technology and should have the right to remain as is.	'Going native', rejection of potential contributions from science; focus on preserving local knowledge in its 'pure form'.
Intercultural	Science is aware that it is only one type of knowledge among others, and that knowledge is always embedded in cultural and historical settings. Science and local knowledge can benefit from comprehensive interaction.	Development of complementary medicine and health care systems; clarification of interactions that have not (yet) been explained by science (e.g. homeopathy, traditional healing).

Third, an intercultural perspective implies to establish the broadest possible field of interaction between different types of knowledge. This means that the interrelation must be based on a process of deliberation that should at least involve the dimensions of practice, values and world views. Another necessary condition is agreement on fundamental ethical principles before embarking on intercultural dialogue. The main one is the will to communicate, which can be formulated as: "I accept the possibility that the Other may be right". The drawbacks of non-acknowledgment, arbitrariness and paternalism presented in the typology can only be overcome by defining this kind of more comprehensive relationship between different types of knowledge.[5]

Step 3: Perceiving the 'scientific community' as an 'epistemic community'

As shown in the former step, in development research (social) reality should be perceived from a constructivist rather than from a positivist perspective. This does not de-legitimise the positivist scientific approach, which is a special form of knowledge production – or more precisely a social construction – obeying its own highly formalised and socially defined rules (Eder, 1998).

The social process of knowledge production generally comprises two closely interlinked central moments. On the one hand the 'constructor' perceives some phenomenon or event. On the other, the 'observer' attributes meaning to the phenomenon. The first step 'naturalises' the social construction by ascertaining what happens in a social or natural environment, while the second step aims to interpret why a phenomenon happens. The integration of the two cognitive steps leads to an understanding that constitutes part of the knowledge an actor uses when envisaging action.

Given this conceptual framework, science can be understood as a community of actors who share a belief in how to produce knowledge about 'nature' and how to give meaning to it. They become what Haas (1992) has called an 'epistemic community', defined as a specific group of social actors who share a belief in a common set of cause-and-effect relationships, as well as common values according to which policies that govern these relationships will eventually be applied. By substituting the belief in a "common set of cause-and-effect relationships" with a belief in a common set of epistemological assumptions related to the human-nature relationship the concept can be used in a wider context in order to consider any local or indigenous form of knowledge as the product of epistemic communities who also share specific sets of beliefs and values.

Within the context of sustainable development, the question of how science should relate to society can thus be reformulated as: How should the epistemic communities of scientists relate to other epistemic communities involved in the societal process of knowledge production? And how to establish a productive dialogue with the society that does not lead to a mere appropriation of parts of local knowledges or silences the voices and needs of non-scientific epistemic communities? The following concrete example from Bolivia illustrates the type of questions and implications that can arise when trying to enter into a dialogue with other epistemic communities.

In the search for an appropriate structuring of the relationship between local and academic forms of knowledge, it became apparent in the practice of transdisciplinary development research that different forms of knowledge represent more than merely different formal

[5] "More comprehensive" does not mean trying to achieve a sum of all knowledges scientific and local – an impossible and crippling task. Instead, it implies sharing of the knowledges (including scientific knowledge) needed to find and define sustainable development options.

epistemological systems. Depending on the specific nature of the connection between thematic-practical, methodological and epistemological aspects, there can be very different consequences for social life – defined here as the result of activity guided by meaning.

The question of hail is of great immediate concern in the context of cooperation in a Bolivian research project that operates a transdisciplinary research project in an indigenous farming community. Hail regularly causes major damage and even destroys the most important staple foods. Interpretation of this phenomenon is thus not only of theoretical but also of eminently practical interest (see Table 2).

Table 2. Ways of interpreting hail from Andean and Western scientific perspectives (adapted from Berg, van den, 1990 and Malberg, 2002).

Scientific worldview	*Andean worldview*
Explanation: Hail is created in cumulonimbus cloud formations at 5000 - 7000 m asl. Precipitation particles of comparable weight are transported upwards, sometimes repeatedly, by updrafts. They collect supercooled water in the process, freeze, and then fall from the clouds as hailstones. A hailstone 3 cm in diameter hits the ground with a speed of 100 km/hr and can cause great damage… Hail seldom occurs over very widespread areas. It is a typically local event that is very difficult to predict.	Explanation: "Mother Earth produces as a function of how humans treat her. If we treat her well, there will be good harvests and protection for everyone. If we treat her badly, natural disasters will occur and the harvest will suffer or may even disappear… "Where blood is shed violently, there will be hail…Together with those responsible, we must use rituals to appease Pachamama…"
Interpretation: Explanation is concerned above all with the *HOW* of hail formation, and is limited to nature.	**Interpretation:** Explanation is concerned above all with the WHY of hail and relates to an integrated whole including nature, human beings and society

When hail is explained as an expression of different cultural patterns of interpretation, the following observations can be made:

The scientific view

The scientific interpretation given for the case of hail is actually based on natural sciences. From this scientific perspective, precedence is given to explanation of the *how* of hail formation. Based on the logic of natural science, no further answer can be given to the question of reasons for the occurrence of hail at a particular place and time, except for reference to chance. Protection against hail from this perspective is understood as protecting human beings from the forces of nature. Hence the focus is not on the life world as such, but on a theoretical explanation of the course of a natural phenomenon, in accordance with certain rules and premises.

By focusing on the question of *how*, and the processes associated with it, the question of *why* – in terms of relations between humans and nature – is not addressed. In order to

answer this question, we must consider the basic premises of theoretical knowledge in the natural sciences. In accordance with the dualistic principles that underlie the natural sciences, a fundamental separation of man and nature, or mind and matter, is postulated. In essence, scientific explanations are an expression of a materialistic view of the world and of human beings. The nature of knowledge production is thus restricted to a clear, pre-established context of theoretical cognition, which cannot recognise more than the foundations on which it is based, even when the question of *why* is being pursued.

For this reason there is no "real" answer to the question of *why* when, for example, physics determines that the conditions for the creation of life developed from the Big Bang, and biology expands on this by determining that life developed through different phases of "natural selection", resulting in its present-day form. The same can be sustained for Darwinsm (selection and survival of the fittest) or the principle of self-organisation (autopoiesis), which is considered to be a mayor element dividing living from non-living matter, and thus is a main feature for distinguishing biology from physics and chemistry. From a philosophical perspective, the essential question in these cases is also one of *how* the Universe and the biological evolution are developing. No reference is made to the questions of why this could be and about which meaning or values could be associated to it.

In the case of social sciences there is no direct interpretation of the phenomenon as such. Social sciences are concerned only indirectly with 'nature'e.g. through trying to document, systematise, analyse and theorise about the subjective ideas the Andean actors relate with the interpretation of the phenomenon according to their own world view. They can make explicit the differences in terms of patterns of interpretation, normative implications, meanings or worldviews etc. without being pushed to evaluate them towards a scientifically defined epistemology. In this regard the perspective of the social science seems to represent a more appropriate position for creating common ground for interepistemic dialogue.

However it is important to consider that it is social sciences and humanities, which are laying the epistemological foundations on which natural sciences are relaying. This means that in a more holistic perspective social sciences and humanities cannot be separated from the problem that natural sciences are facing, because without them it is impossible to formulate the epistemological foundations of natural sciences.

The Andean view

The starting point for understanding the Andean worldview of the Aymara and Quechua Indians is a consideration of their daily activities. The example presented here is an expression of specific knowledge rooted in activity and orientation.

From the Andean perspective the question of *why* hail occurs is the primary issue. According to San Martín (1997), daily life is perceived as a coherent context involving an interplay of social, spiritual and natural-material aspects of life. From the Andean point of view, it is clear that humans, on the basis of their social, cognitive and emotional capacities, participate in a spiritual world that is shared in common with social life and natural-material processes, which are accordingly seen as a connecting element.

The search for protection from hailstorms is thus seen as an ethical challenge that is guided by a specifically Andean relationship between human beings and nature. It is based on the premise of the thorough interdependence of social, spiritual and natural processes. In epistemological terms, this amounts to a monistic perception of interdependent relationships that is rooted in a spiritual point of view.

Even if the epistemological interpretation of the meaning of hail is helpful in terms of analysis, it is necessary to be aware of its social constitution. Action-guiding values, and their implications for theoretical knowledge – in the sense of philosophically defined epistemology – can be only partly perceived by most actors on a cognitive basis.

Against this background, the implications for practice of the epistemological differences between the indigenous and scientific understandings of hail becomes clear: depending on the type of interpretation, the various forms of protection against hail may or may not make sense. Thus, when dealing with different forms of knowledge one also has to consider that every form of knowledge has practical aspects as well as a methodological and epistemological dimension. For the scientific community, the issue at stake is how it can embark on a dialogue with actors that represent other forms of knowledge. The case discussed so far shows that a real dialogue between representatives of natural or social sciences and Andean people means to engage in a dialogue between different epistemic communities in which the relationship between mind and matter seems to represents a mayor the most fundamental element of divergence.

Step 4: Epistemological self-reflection

The analysis of the differences between Andean and scientific forms of knowledge reveals that searching for epistemological bridges requires communication about fundamental and not just gradual differences between the different forms of knowledge. Because of the fact that this implication in both sides is relatively less explicit an epistemological self-reflection is considered to be an important element of a dialogue between the epistemic communities involved.

Foundations of epistemology from a scientific perspective

In the case of sciences a first problem rising form self-reflection is related to the differences between natural sciences at the one hand and social sciences and humanities at the other hand. Natural sciences are philosophically rooted in a dualist vision on mind and matter as expressed most prominently by Immanuel Kant. In methodological terms this vision was narrowed down through positivism, which today – by emphasising on the principles of reductionism and materialism – constitute a basic feature of natural sciences. Consequently the range and forms of diversity of experiences are drastically reduced: essentially, things are considered to be real only if they manifest themselves in matter and can be explained in terms of causality.

According to Giddens (1993) structural and functional schools of social sciences and humanities – although as such they are separated by fundamental difference - are tending to take naturalist and objectivist position. While functionalism adopts basic principles of biology in the analysis of social reality structuralism rejects this proceeding radically replacing it by the idea of a mental structure governing social reality. A countertendency is represented by hermeneutic or interpretative schools of social sciences: they point to a sharp and dividing line between them and structuralism and functionalism represented by subjectivity as the precondition of any cultural and historic experience. While structuralist or functionalist positions represent an imperialism of the object hermeneutics tend to an imperialism of the subject (Giddens, 1993).

In terms of the question about the relation of mind and matter social sciences and humanities are more engaged in defending themselves against the imperialism of the ‘object’ rather than addressing the question as something that could be of great importance for establishing common epistemological ground with positivist sciences. In a more interdisciplinary perspective this means that in the field of social sciences the same contradictions are found as in the case of natural sciences and philosophy. Considering the

question about the how and why of natural or social processes this implies to postulate that sciences are not yet able to offer a common epistemological framework that is capable to fulfil the principle of interdisciplinarity. Taking into account the epistemological implications allows to sustain that this will be difficult – if not impossible – as long as it is not likely to find a different answer to the mind-matter issue than the de-facto co-existence of two contradicting versions.

From the point of view of a transdisciplinary understanding of sciences, we believe that an examination of the difficulties in dealing with the question of *why* is an important prerequisite. Excluding questions of meaning – although completely reasonable on a positivist scientific basis – leads to a situation in which scientifically obtained knowledge becomes distanced from the life-world of the people, which, according to one of the few uncontested postulates of the social sciences, is essentially meaning-oriented. This tension-laden distance results from the scientific postulate of value neutrality, which is an expression of an essentially materialistic theory of science and of knowledge. This theory is rooted in the idea that there are "eternal and unchanging types of thought – represented, for example, by 'categories' or rules of what we call 'logic' – which underlie the thoughts expressed in speaking or writing by human beings throughout the ages" (Elias 1996:41).

To prevent this prerequisite from having a constraining effect, it is necessary to make a transition from a philosophical to a sociological theory of science and knowledge. In place of an egocentric approach to problems, the development of different types of thought must also be taken into account. This can be understood as a development of structures of thought in a certain direction "which itself constitutes an aspect of the development of social structures" (Elias, 1996:45). This sociological orientation can liberate the materialistic theory of knowledge from its need to exclude other epistemological views, without forcing it to surrender its 'raison d'être' per se. In this sense, it remains fundamentally open to historical development, without denying a priori its own further development. It thus moves away from a position that makes it difficult in both a theoretical and a practical sense to come to terms with other forms of knowledge, as well as to recognise the extent of the usefulness of scientific knowledge for the purpose of formulating policy and to accept responsibility accordingly.

Given this background, it is clear that a sociological theory of knowledge – aside from its relation to practice, values and worldview – must also take account of the structures of thought that guide it. Leisegang (1928) very skilfully elaborated the most important structures of thought in Western philosophy and their relation to the sciences. He traced the great variety of philosophical systems to the following three structures: circles of thought (mysticism), conceptual pyramids (rationalism), and mechanics (physics, chemistry). Without fundamentally questioning the bases of these various structures of thought, this view makes it clear that different structures develop in specific thematic areas. This led Leisegang to the realisation "that all the absurdities and the outrages that we encounter in the history of philosophy, religion and science arise from the fact that a structure of thought developed within a certain area is applied to the entire world in all its manifestations, as if these all had the same structure as the self-contained area. The major unilateral worldviews all arose from unwarranted application of this sort." (ibid, p. 442). The same author goes on to say that the structures of thought that underlie a typology so conceived must be left to co-exist as equal and independent entities – at least at the outset. Whether and to what extent these structures relate to each other is a subject for further investigation. The frequently expressed hasty conclusion that different structures of thought can be traced to an original form common to all cannot be excluded a priori, but it basically represents simply a linear projection of one structure of thought onto all the others.

Of particular importance from a sociological perspective is the fact that these three types of thought, and sometimes others as well, intersect, complement or impede each other in the daily lives of most Western-educated individuals. Drawing upon Jaspers, who designated these three types as "thought techniques", Leisegang maintains that every individual in our time – and in our cultures, it should be added – moves involuntarily in all three of the spheres of these thought techniques. The sheer and unfathomable variety of cultures and subcultures that exist in modern societies, as well as ways of life that are even more individually refined, could thus be understood as different structures of thought bound together in different quantities.

Another important result of epistemological self-reflection relates to questioning of the exclusive nature of a single theory of knowledge. Since the recognition of the most important – philosophically and not empirically sustained – postulates of Kant's *Critique of Pure Reason* as the epistemological basis of the modern empirical sciences, the potential of human consciousness to perceive the "true nature" of the external world through thought remains denied. This dualistic view of mind and matter is by no means the only possible theory of knowledge, but it is the one which corresponds best with current understanding of "progress" and hence has met with a correspondingly high degree of acceptance.

This becomes clear, for example, in approaches that – beginning with valid scientific methods and results – can make significant contributions to transcending a dualistic theory of knowledge. Here we can note examples such as the work of the linguistic philosopher Robert Brandon (1994). Starting with an analysis of discursive practice, Brandon constructs a theory of concepts that contrasts with the Kantian dualistic view of the conceptual and the material, in general and specific terms, as well as in terms of spontaneity and receptivity: "Concepts conceived as inferential roles of expressions do not serve as epistemological intermediaries, standing between us and what is conceptualiszed by them. This is not because there is no causal order consisting of particulars, interaction with which supplies the material with thought. It is rather because all of these elements are themselves conceived as thoroughly conceptual, not as contrasting with the conceptual. The conception of concepts as inferentially articulated permits a picture of thought and of the world that thought is about as *equally*, and in the favoured cases *identically*, conceptually articulated." (Brandom, 1994:622; italics in the original)

Foundations of epistemology from the Andean perspective

Ethnographic, sociological and ethno-historical research in the Andes has shown – in the case of other forms of indigenous knowledge, for example – that the processes of colonisation, Christianisation, and present-day globalisation have had a major influence on the spiritual lives of the Aymara and Quechua Indians (van den Berg and Schiffers, 1992). One central phenomenon here relates to doubt about the nature of the reality of the spiritual realm of daily life. Because this realm is also of fundamental importance as the source of meaning for interpreting social processes and natural-material processes, it is not surprising that people in Andean communities see it as the primary task of their "development" to create new convictions about the nature of the reality of the "spiritual" in human beings, nature and society (Rist 2002). The influence of recent history has led to an initial stage of "dualisation" of the spiritual and material levels of existence traditionally perceived as a single unity.

In the course of recent history, however, there has been a clear trend towards expansion of conscious access to the values and principles of their own forms of knowledge. This growing form of reflection is leading on the one hand to knowledge of and distinction among special patterns of action, orientation and interpretation. From this develops an interest in reflective processing of the connections between these three levels of

knowledge. Rist et al (2003) have shown that transmission of knowledge related to action and orientation by means of primary and secondary socialisation alone no longer satisfies the cognitive requirements of Indian farmers. Consequently, a social process can be observed that leads to construction of increasingly more explicit patterns of interpretation. These in turn have the effect of intensifying, questioning or rejecting patterns of action and interpretation. Here it is especially important to observe that the process of developing patterns of interpretation, and related configurations of patterns of action and orientation, is one whose possibilities are not constrained a priori by a preconceived methodological framework, as in the case of science.

These reflections support a process that leads to continual renewal and expansion of the paradigmatic foundations of the indigenous worldview. Contact with other worldviews – particularly scientific ones – is of great importance here. In social practice, connection between "traditional" indigenous structures of thought that are similar to the intellectual tradition of mysticism, and elements of rational and causal structures of thought, can be observed. This leads to the development of fundamental elements based on experience, and largely inductively constructed that could be combined into their own theory of knowledge in future.

As showed by Haverkort and Hiemstra (1999) the outstanding role of spiritual life as the main ordering element of material and social life is also considered to be a distinguishing element with regard to science in the cases of other Latin American as well as Asian, African or even alternative European cosmovisions. A mayor difference between Western science and indigenous forms of knowledge are therefore represented by the role and function of mind in regard to matter.

Step 5: Exploring common ground for cooperation between epistemic communities

The analysis presented so far argues that the main dividing element between the scientific and most other epistemic communities consists of different understandings of the nature of mind and matter, and of the consequences this has for the constitution of action-guiding values. This makes it possible to envisage a common epistemological ground between scientific and non-academic epistemic communities under the following two conditions: First, the epistemic community of scientists must admit the hypothesis that the mind could be coupled with the phenomena that are observed and described through their specific methodology. Second, local epistemic communities must be willing to process their insights and experiences in reflexive and explicit ways, as a precondition for a dialogue with the scientific epistemic community.

Many examples of such cooperation between 'alternative', local or indigenous epistemic communities and the scientific one already exist. Scientific and non-scientific experts have tried to define new forms of dialogue and cooperation in almost all spheres of life. In mainstream science, medicine is probably the area where cooperation between different epistemic communities has always been an important issue. This cooperation has been stronger or weaker throughout the centuries, depending on many factors. Currently there is a stronger cooperation between normal and post-normal medicine, as shown in the growing importance of complementary medicine in the last few decades. The contribution of non-academic forms of knowledge to health, healing, medicinal products of health care is a widely underestimated resource for improving global health situations (Bellavite and Signorini, 2002; WHO, 2002).

Interesting research is being carried out e.g. between representatives of several epistemic communities practicing distance healing and medicinal science. Various forms of distant healing, including prayer and 'psychic healing', are widely practiced, but in many cases

insufficient formal research has been conducted to conclude whether such efforts actually affect health (from a scientific point of view). One exception is the case of distant healing treatment, observed according to accepted scientifical norms. Treatment was performed by self-identified healers representing many different healing traditions. After six months, a blind medical chart review found that treatment subjects acquired significantly fewer new AIDS-defining illnesses, had lower illness severity, and required significantly fewer doctor visits, fewer hospitalisations, and fewer days of hospitalisation. Treated subjects also showed significantly improved mood compared with controls (Sicher et al., 1998).

Another field of traditional cooperation between scientific and alternative epistemic communities is organic farming. The empirically and theoretically developed practices of biodynamic agriculture rely on a perception of minerals, plants, animals and humans as 'embodiments' of psychological-spiritual potentialities, thus admitting the possibility of interactions between the mineral, organic, psychological and spiritual spheres of life. Specific preparations aim to 'dynamise' these kinds of interaction, taking into account the influence of astronomical rhythms on plant growing. Agriculture is thus understood as the creation of optimal conditions for the 'incarnation' of psychological-spiritual potentialities into the mineral and organic spheres of life (Rist, 2003). In the course of a 21-year study of agronomic and ecological performance of biodynamic, bioorganic, and conventional farming systems in Switzerland it was shown that homeopathic applications of special biodynamic preparations lead to a statistically highly significant increase of soil fertility, biodiversity of vascular plants and microbiological functional diversity (Mäder et al., 2002).

Cooperation between biodynamic agriculture and representatives of science also made it possible to demonstrate scientifically that tree stem diameters fluctuate with tides caused by the moon (Zürcher and Cantiani, 1998), and that lunar cycles influence a plant's secondary chemistry. The latter result offers a scientific explanation for indigenous communities' successful cutting of leaves for roof covering during the full moon: this is when the production of leaf carbon is highest and leaf nitrogen is low (Vogt et al., 2002), leading to higher durability of the material.

The above examples should not only be assessed from a utilitarian point of view according to which everything that works well should be used in order to improve health and farming systems. The results of these experiments also provide new insights into the epistemological dimensions of the dialogue between epistemic communities: Besides clarifying practical aspects they provide new elements proving that the interaction between mind and matter are at least possibilities that cannot be excluded 'a priori'.

This epistemological position is further strengthened by innovative results from physics and biology. Modern physics offer interesting insights into the mind-matter debate. In a philosophical analysis of the latest results of modern physics, Hans Peter Dürr, long-time director of the Max Plank Institute for Physics and Astrophysics in Germany, who was awarded the alternative Nobel Prize in 1987, concludes that the materialist position regarding the mind-matter problem is no longer valid. The idea that matter represents a constant and primary quality that determines its inherent aspects as shape cannot be sustained any longer, he argues. Indeed, "when we take matter apart, nothing remains at the end that reminds us of matter. In the final analysis, no substance is left, only form, shape, symmetry, relation. Matter is not made of matter!… We have an inversion: relation comes first, substance is secondary. Matter is a phenomenon that only appears on observing things more roughly, so to speak. Substance is flowing form. Maybe we can say: at the outset what remains is only something that resembles the mind – holistic, open, alive: potentiality. Matter is the scoria of this mind: it can be taken apart, is finite, determined. Reality. In potentiality no clear cause-and-effect relation is lefts. The future is open in what is essential" (Dürr, 2002, S. 49).

By referring to 'shape' as something related to a kind of spiritual potentiality, Dürr is close to what renowned biologists argue. Adolf Portmann, for example, interprets results from recently acknowledged morphological studies and questions the reductionist view of organisms as 'genetic machines' supposed to be main actors in the arena of the so-called 'survival of the fittest'. By analysing the elaboration of shells among molluscs, and of horns and antlers among ungulates, he concludes that "the production of forms in the animal body goes far beyond the elementary needs for preservation" (Portmann, 1967:210). He sums up such phenomena in the following way: "Genetics allows us to look behind the scenes of the theatre. We may watch the way in which the actors get ready, how the machinery produces the effects of thunder and rain; how everything works together so that, by the complicated action of many invisible helpers, a play having an intelligible sequence is finally unfolded before the spectator. But such a glimpse behind the scenes tells us neither the gist of the play nor its significance" (Portmann, 1967:161).

Another voice questioning materialist assumptions also comes from biology: Maturana and Varela argue that the principle of 'autopoiesis' is an inherent quality of all living organisms. The concept is arguably one of the most important ideas in the history of biology. It expresses the difference between living organisms and non living matter, represented by the capacity of all organisms to self-organise all related processes in such a manner that the product is always itself (Maturana and Varela, 1980). This means that chemical and physiological processes have a directionality that they would not have outside the organism. A reductionist, materialist and causality-based views of life is seriously questioned by this fundamental aspect, at least as long as biology cannot say how and why material processes achieve to come to generate autopoiesis. A growing number of scientists have this view of life. They reject reductionism as the only way of explaining biological evolution, suggesting that holistic analytical strategies have a greater potential to explain biological phenomena (Margulis, 2000).

In the first part of the 20th century, the palaeontologist Pierre Teilhard de Chardin (1978) critically revised the results of modern biology and geology. Instead of accepting conformist theories of evolution based on the description of how things develop he took an interest in investigating why evolution seems to move in a specific direction. Submitting palaeontological findings to this philosophical question, he adapted the concept of 'noosphere' as developed by Vernadsky (1998)[6] at the beginning of the 20th century.

De Chardin suggested that the noosphere is related to the spiritual evolution of mankind and appears after the emergence of the 'geosphere' and 'biosphere'; it refers to the part of the world that is created by man's thought and culture. It converges to a point 'omega' representing the unification of all thought and cultures at a global level. Teilhard de Chardin shows that the noosphere is the domain in which the noosphere develops and expands. The significant increase in global population and new forms of knowledge lead to an extraordinary augment in the use of technology that is translated into drastic increase of human intervention in natural processes. This means that today the geosphere and biosphere are increasingly more directly influenced by the processes originating from the noosphere. In other words, the noosphere is becoming increasingly embodied in the geo- and biospheres.

[6] Vernadsky stated that the evolution of the biosphere goes in the direction of a self-stabilisation of the biosphere through several stages. He called the final stage of this process the noosphere. The most important characteristic of the noosphere is that the instrument of its stabilisation appears to be human or as he called it scientific reason. Scientific thought is seen as a function of the biosphere of a planetary phenomenon (Vernadsky, 1998).

Whether one shares Teilhard de Chardin's teleological convictions on the origins, significance and direction of evolutionary processes or not is not the point to be discussed in this context. What is suggested here is to take the concept independently form its origins – in a phenomenological sense - expressing that the geospere, biosphere and atmosphere have become – and still continue to become – more and more dependent on what the global society and its component thinking, knowing and doing (Bellmann et al., 2002).

Many phenomena related to current environmental, political, social, economic and cultural crises are expressions of a noosphere that is in a rapid process of expansion and consolidation. From this point of view, the major challenge that the now closely linked societies on Earth need to face is to shape the noosphere in a much more careful and conscious way than has been the case so far.

With regard to the mind-matter hypothesis the concept of the noosphere makes it evident that conventional academic positions which relegate action-guiding values and principles to the realm of subjectivity – supposed to be unconnected with 'reality' – are no longer tenable. Such a position might have been possible in an embryonic stage of the evolution of the noosphere, but not in the current situation where the geo- and biospheres are severely threatened by non compatible values, thought and concepts predominating in the noosphere.

Understanding the noosphere as the sum of thoughts and knowledge requires recognising that the production and reproduction of these elements are closely related to social structures that have a great impact on the way knowledge is created, recreated and passed from one group or even from one generation to another. Because the noosphere cannot act without being connected to social structures, we suggest to use a further concept: the 'sociosphere', as defined by Hofkirchner and Fuchs (2003). The sociosphere is the space in which social relations concerning resources (economy), regulations (policy) and social rules (culture) are produced and reproduced. In the sociosphere, social actions are carried out, tangibles and intangibles (material or immaterial goods) are produced, consumed and reproduced. Every social actor contributes to co-designing the collectivities through which the supply of goods is provided. In this perspective there is an intimate relationship between the noosphere and the sociosphere.

The debate about the '(world) risk society'[7] and individualisation (Beck and Beck-Gernsheim, 2002) shows that a clear shift in the processes of knowledge production and reproduction takes place in globally 'modernising' societies: firm social integration can no longer be guaranteed only by transcendental consensus, joint material interests or national consciousness. Social integration is driven more and more by individually created groups and subcultures based on increasing levels of reflexivity leading, first, to a 'modernisation' of traditions and then to the reflexive modernisation of the foundation of modernisation itself (Beck, 1991). This means that the relation between socio- and noosphere is characterised by an increasing importance of the latter, the more significant reflexivity becomes. Consequently, the geo-, bio- and sociospheres depend increasingly on impulses from noosphere dynamics.

[7] "The concept of risk is a modern concept. It requires decisions and attempts to render the unpredictable consequences of civil decisions predictable and controllable. … The novelty of the world risk society lies in the fact that we, with our civilizing decisions, cause global consequences that trigger problems and dangers that radically contradict the institutionalised dangers and promises of the authorities in catastrophic cases highlighted worldwide (like in Chernobyl and now in the terrorist attacks in New York and Washington)." http://logosonline.home.igc.org/beck.htm

The emerging epistemic community of post-materialist scientists

The above examples, which could easily be extended, make it possible to perceive that all these different epistemic communities seem to converge towards a horizon in which knowledge production is seen as a societal process that includes current science without subordinating the process itself to science and scientific discourse. A new way of understanding sustainable development and the role of science is emerging, and the hegemonic position of science is being relativised to the benefit of other discourses and science itself. The epistemic communities of sciences involved in the debate on sustainability have a strong commitment to interdisciplinarity, and are now increasingly sharing a transdisciplinary understanding of science. Communication and cooperation with non-scientific epistemic communities are challenging current approaches to research. Innovations of the normative, technological and practical aspects in all spheres of life are becoming mayor issues. Instead of meeting 'truth' criteria, this type of research activity is oriented towards a societal mode of knowledge production aiming to achieve 'socially robust' knowledge, rather than reliable and 'objective' truth (Nowotny et al., 2001).

Another important feature of the societal mode of knowledge production is the growing interest in inquiring *why* things are described in a particular manner by the conventional social or natural sciences. Moreover, the examples show that a shift from a materialist understanding of nature and humankind to an understanding which at least accepts a mind-matter hypothesis, is not incompatible with the research process as such. Such a shift only leads to contextualising the findings of research within a broader context than in the case of materialism. Connected to this is a shift from reductionist to more holistic approaches to scientific methodologies. Additionally, to acknowledge that the geosphere, biosphere and noosphere are ruled by qualitative differences implies also to admit the possibility of a co-existence of different forms of thinking.

A comparison between these basic elements of the new mode of knowledge production with existing mainstream science provides evidence for a fundamental epistemological shift. The idea that mind is an integral component of reality is the main new – and at the same time differentiating – element. This premise characterises a broad epistemological framework for interacting with many other non-materialistic forms of knowledge produced by indigenous and other local epistemic communities. We therefore suggest to conceive of this form of knowledge production as an emerging 'post-materialist' understanding of science. Post-materialist science is built through dialogue and cooperation between different epistemic communities. It includes findings from materialist scientific research and is therefore not identical with religions. The main difference between materialist and post-materialist science consists in the fact that the process of reflection is not limited to one epistemological position. Reflection is opened up towards a wider epistemological horizon in which the materialist position is just one among other cognitive positions: exploring the meaning of what is described by materialist science represents a major methodological innovation of this post-materialist understanding of science (as observed in the above-mentioned examples from Dürr, Portmann and Teilhard de Chardin etc.).

Historically speaking, this implies a broadening of the 'human project' initiated by the Renaissance, which realised that human beings are free to determine their lives themselves, as described for example by Pico della Mirandola (1463 – 1494) in his *De dignitate hominis* (Oration on the Dignity of Man; the speaker in the following quote is God) and illustrated in Figure 1:

> "Neither a fixed abode nor a form that is thine alone nor any function peculiar to thyself have we given thee, Adam, to the end that according to thy longing and according to thy judgment thou mayest have and possess what abode, what form, and what functions thou thyself shalt desire. The nature of all other beings is limited and

constrained within the bounds of laws prescribed by Us. Thou, constrained by no limits, in accordance with thine own free will, in whose hand We have placed thee, shalt ordain for thyself the limits of thy nature." (Quoted from Ernst Cassirer, Paul Oskar Kristeller and John H. Randall, eds., *The Renaissance Philosophy of Man*, Chicago: University of Chicago Press, 1948, pp. 223-225)

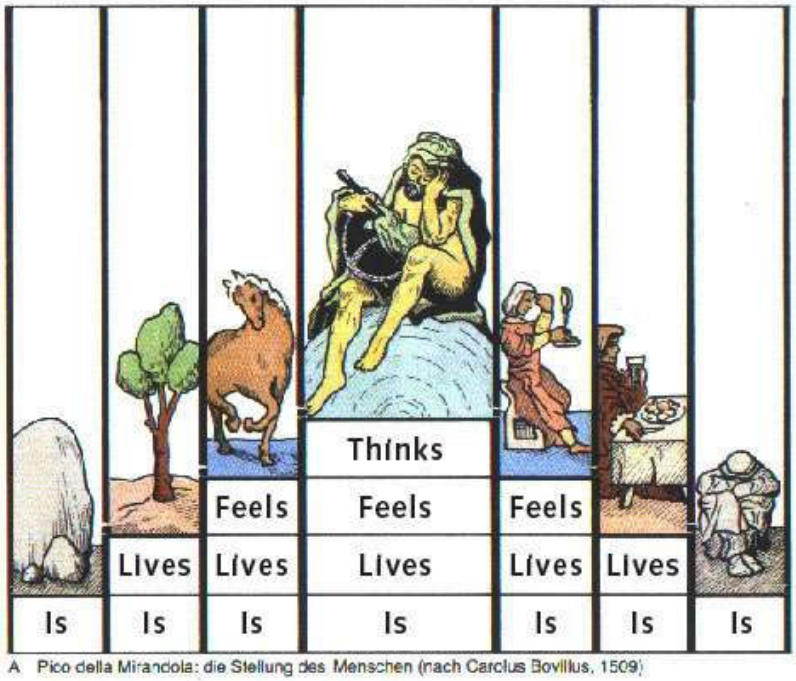

Figure 1: The position of human beings in the Creation according to Pico della Mirandola (after Carculus Bovillus, 1509)

By contrast with the Renaissance, a post-materialist approach to science stresses that this self-determination has also led to a human-based determination of the future of the geosphere, biosphere, and sociosphere at a global level. One of the leading experts in earth system analysis, Schellnhuber, refers to the problem of control through humans posed by the current critical global environmental situation, and sums it up in three fundamental questions that global society must ask itself: "First, what kind of world do we have? Second, what kind of world do we want? Third, what must we do to get there?" (Schellnhuber, 1999).

Thus, the very anthropocentric framework proposed by Pico della Mirandola needs to be broadened. Human beings' freedom and self-determination have such a strong influence on the current and future state of the planet that they must reflect on the impact of their ethical concepts, knowledge and action. There is a shift in perception of the role of human beings in the world: while the Renaissance defined Man as the 'crowning glory of God's creation', today human beings are perceived as a major developmental force shaping a noosphere through reasoning and reason-based action. This force has become the most influential factor with regard to the geological, biological and social realms. From 'crowning glory' humankind has become a major steward of the evolutionary process. This implies the need for creating new ethical horizons allowing to recognise that this can only

be achieved based on the integration of knowledge about how evolution is organised and why it is as it is.

This reveals an additional characteristic of emerging post-materialist science: it acknowledges that some basic qualities shape the different spheres of life as expressed in life's material, organic, psychological and spiritual dimensions. For the purpose of research and understanding, this also implies the need to conceive of other forms of thinking in addition to causality-based mainstream science (see figure 2).

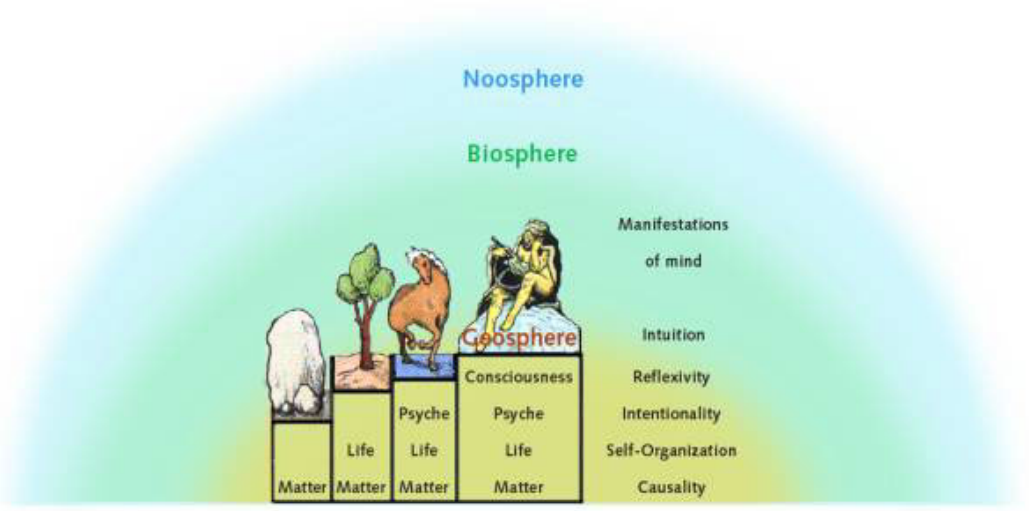

Figure 2: The relationship between human beings and nature underlying a post-materialist approach to science (based on Pico della Mirandola, modifications by the authors)

With regard to cognition, a central issue also requires further exploration: that of the relationship between perception and concepts. One possibility of avoiding the materialist assumption of a duality of mind and matter is proposed by Brandom (1994). He offers evidence from the point of view of analytical philosophy that reality and concepts are the same. This is also maintained by the epistemic communities of biodynamic agriculture, complementary medicine, and Dürrian interpretation of modern physics. Pico della Mirandola's 'human project' could thus be broadened, considering the concepts and principles that are uncovered by the sciences and the meanings they portray as 'materialised' manifestations of the mind. This allows to redesign the 'human programme' and consider the coexistence of different levels of materialisation of the mind in different realms of life. Each realm is constituted by different overall principles ranging from causality (material), self-organisation (life), intentionality (psyche) to reflection (consciousness).

With regard to the position of human beings, Pico della Mirandola's anthropocentric vision is modified in so far as post-materialist science recognises that today, almost every human thought can have a direct impact on the processes that occur in the socio-, bio-, and geospheres. Man is no longer the crowning glory of evolution; humankind is at the same level as other beings, which form part of a reciprocity-based co-evolution of all spheres of life.

Post-materialist science can significantly contribute to emerging tasks facing global society. By relying on more than one form of knowledge, one form of thinking and a single epistemological position, post-materialism aims to integrate diversity not in the post-

modern, relativist sense of 'anything goes', but rather in the form of a working hypothesis that makes it possible to re-think the conditions that enable it to contribute to sustainable development, accounting for the crucial issues of normativity and power. Post-materialism can help to re-shape the process of knowledge by interrelating scientific insights with the broader social and ethical meaning they have, on the basis of a dialogue and cooperation between different epistemic communities. In the words of Habermas (1988) this means to leave behind the exclusivity given to scientifically produced rational knowledge; by including instrumental, ethical and aesthetical knowledge and the corresponding wide range of actors a post-rationalist manner of knowledge production can be emerging. In stead of the determination of an 'objective truth' a meaningful combination and integration of different forms of knowledge is at stake which is achieved through a process of intersubjective – that means collective – validation of 'facts' by all actors involved.

That post-materialism also meets a need of society at large is reflected by the fact that in many 'modern' countries there is a growing distrust among the greater proportion of the population vis-à-vis the possibilities of modern science to solve current problems of global change. A comparative survey of environmental commitment in Norway, Germany and Japan shows that between 43-75% of the population does not believe that science will be able to solve environmental problems. This is also reflected in the fact that 10-23% of the population in these countries are orienting their lives on non-materialistic values, and that among these the proportion of people engaged in environmental movements is the highest (Nyberg, 1997).

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