

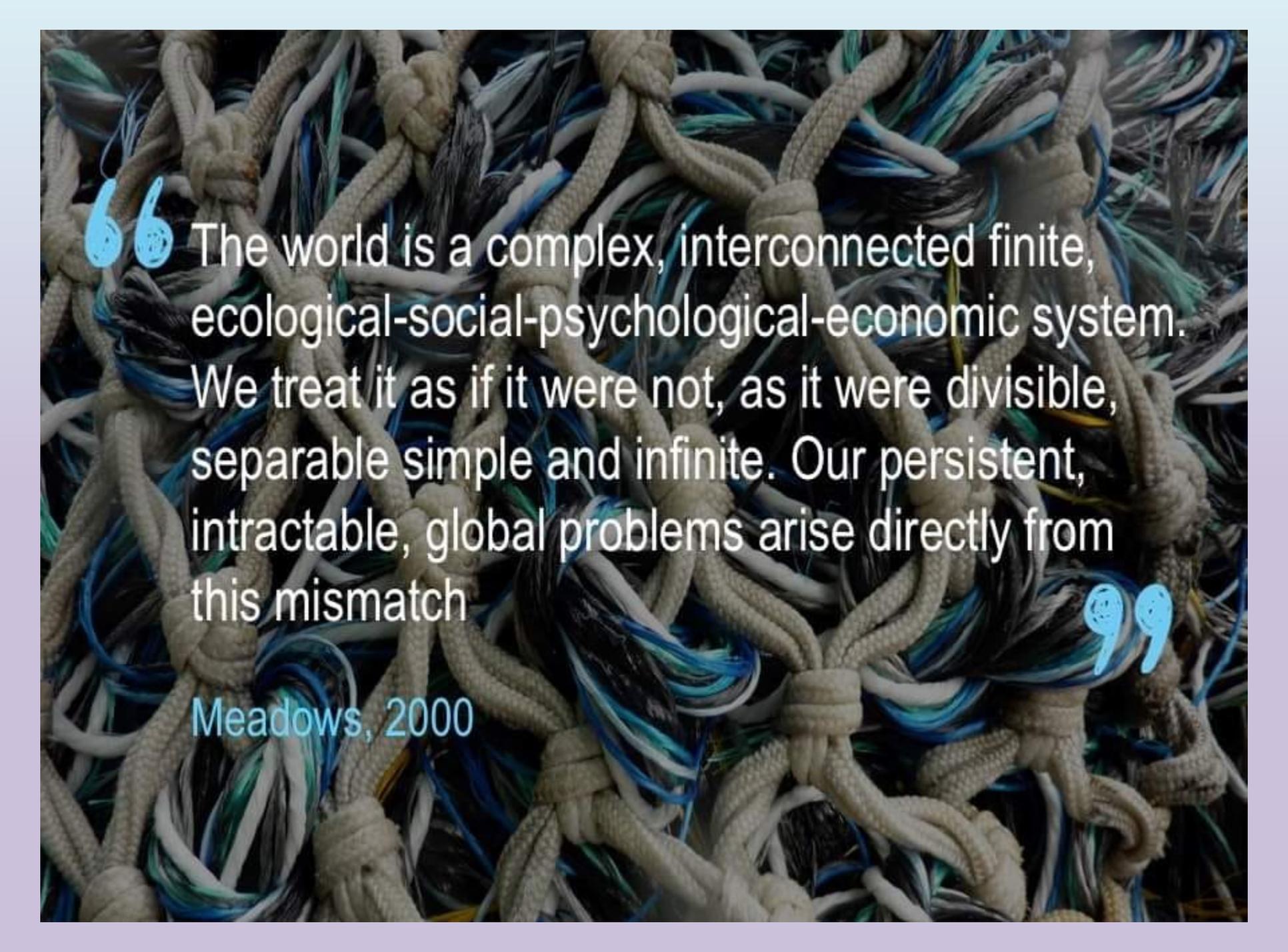
# Internalisasi Sustainability Science dalam Kurikulum Pendidikan

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Sustainable Sciences, IPB University**



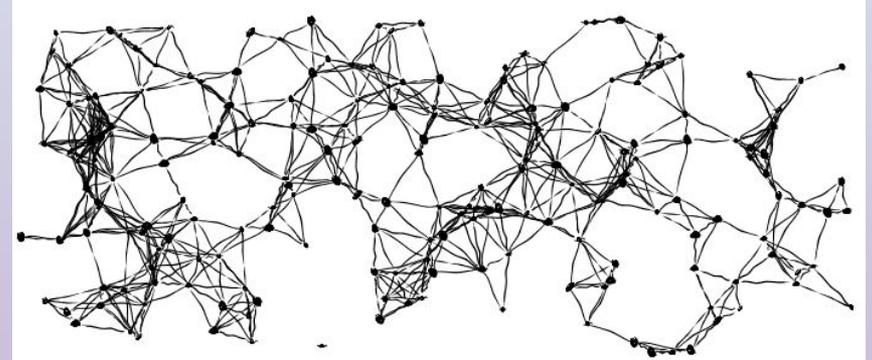
**4<sup>th</sup> Transdisciplinary Tea Talk, CTSS IPB  
16 August 2019**



“ The world is a complex, interconnected finite, ecological-social-psychological-economic system. We treat it as if it were not, as if it were divisible, separable simple and infinite. Our persistent, intractable, global problems arise directly from this mismatch ”

Meadows, 2000

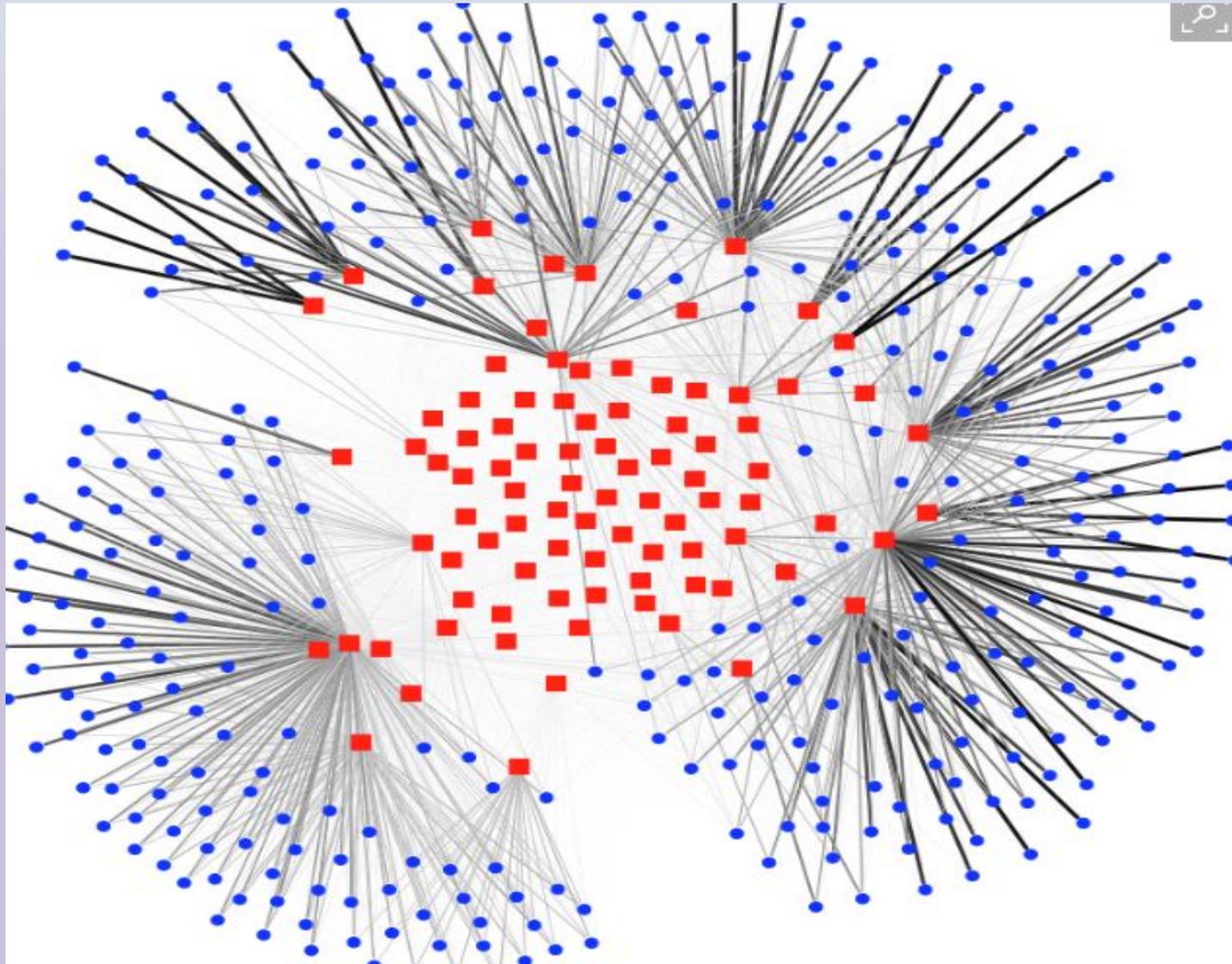
# SUSTAINABILITY and COMPLEXITY



# SCIENCES

- Methods of inquiry
  - Experiments
  - Observation
- Construction of theories
- Enlightenment Period: The Age of Rationality
- Kant: “Dare to Know!  
Have courage to use your own reason
- Science develops with reductionist approach, to unravel the complexity of life
- The black box of nature is being unraveled through deductive and inductive approach
- Development of different disciplines of sciences, physics, biology, astronomy, etc : NORMAL SCIENCE

# SUSTAINABILITY SCIENCE: UNDERSTANDING COMPLEXITY



# SEJARAH SUSTAINABILITY SCIENCE

- Sustainability Science muncul di abad 21 sebagai suatu disiplin ilmu baru. Diperkenalkan pertama kali dalam Kongres Dunia "Challenges of a Changing Earth 2001" di Amsterdam yang diselenggarakan oleh International Council for Science (ICSU), International Geosphere-Biosphere Programme (IGBP), International Human Dimensions Programme on Global Environmental Change (IHDP) and World Climate Research Programme (WCRP).
- Sustainability science diturunkan dari konsep sustainable development dan environmental science
- Pada pertemuan di Friibergh Manor, Sweden (October 2000) sekelompok saintis dari berbagai negara mendiskusikan kemunculan 'sustainability science' (Kates et al., 2001).
- Kelompok ini menyepakati bahwa pendekatan2 sustainability science harus:  
“ encompass the **interaction of global processes** with the **ecological and social characteristics of particular places and sectors**; integrate the effects of key processes across the full range of **scales from local to global**; and achieve fundamental advances in our ability to address such issues as the **behaviour of complex, self-organizing systems, as well as the responses of the nature-society system of governing to multiple and interacting stresses** ” (Jäger, 2009).

- Ostrander mendefinisikan "sustainability science" *is a transdisciplinary method of organising research to deliver meaningful contributions to critical issues of resource management and rigorous policy analysis.*"
- Agenda Utama sustainability science menurut Clark and Kates (2008) menekankan pentingnya **pendekatan sistem** serta menekankan pentingnya **interaksi-interaksi yang feasible antara system alam dan system manusia (between natural and human systems)**.

- “sustainability science is implementation-oriented in areas dealing with persistent problems of unsustainability that have a high level of complexity” (Jager, 2009)
- “focuses on the design and running of processes linking knowledge with action to deal with persistent problems of unsustainability and to foster transitions to sustainability” (Jager, 2009)
- sustainability science draws upon scholarly attempts to rethink the interaction between nature and society (e.g. Schellnhuber, 1999), the global and the local (e.g. Jasanoff and Martello, 2004), science and democracy (e.g. Leach et al., 2007).

# Goal Sustainability Science

- The field of sustainability science aims to understand the complex and dynamic interactions between natural and human systems in order to transform and develop these in a sustainable manner

# What is Sustainability Science?

- Is it an objective science which seeks to maintain the scale of human society within physically defined carrying capacity of planet?
  - Interdisciplinary endeavor: ecology, biology, physics, chemistry, etc. plus policy sciences
- Or is the goal to ensure that costs of human encroachment on the sustaining ecosystem do not outweigh the benefits for this or future generations?
  - Transdisciplinary endeavor: ethics, philosophy, psychology, economics, cultural values, etc.
- Meeting the needs of the present in an equitable and fair fashion without compromising the ability of future generations to meet their own needs.

# What is sustainability science?

- Sustainability science harnesses science and technology for sustainability in a way which focuses on the:

“ ... **dynamic interactions between nature and society**, with equal attention to how social change shapes the environment and how the environment shapes society”  
(Clark and Dickson, 2003)

- Sustainability Science involves:

“ .... **Transdisciplinary research which focuses on human-environment relationship**, through which divides between disciplines and between knowledge producers and users are bridged in order to practically advance **sustainable development** ...”

# Sustainability Science – an approach to knowledge production

- Beyond disciplines
- Problem-solving
- Participatory
- Process-oriented
- Implementation
- Paradigma baru :
  - harus melintasi skala magnitude yang berbeda-beda (waktu, ruang, dan fungsi), multi keseimbangan (dinamis), multi aktor (kepentingan) dan sistemik thinking

# Sustainability science requires interactions at every step!

- Joint design of the problem to tackle
- Joint production of knowledge
- Joint implementation of solutions

# **KNOWLEDGE SYSTEMS: LEARNING FROM THE PAST, ADAPTING FOR THE FUTURE**

**A QUEST FOR SUSTAINABILITY  
NEW FRONTIERS IN SUSTAINABILITY RESEARCH**

**CONTOH SUSTAINABILITY SCIENCE**

# Local Knowledge: Subak System, Bali.



Water Reservoir



The Landscape



The Landscape

**CONTOH SUSTAINABILITY SCIENCE**

# Requires system thinking

- Inherent complexity
- How do the pieces interact?
- Study of a rapidly evolving system
- What are the feedback loops driving system evolution?

**Table 1** The core questions of sustainability science (Kates et al. 2001)

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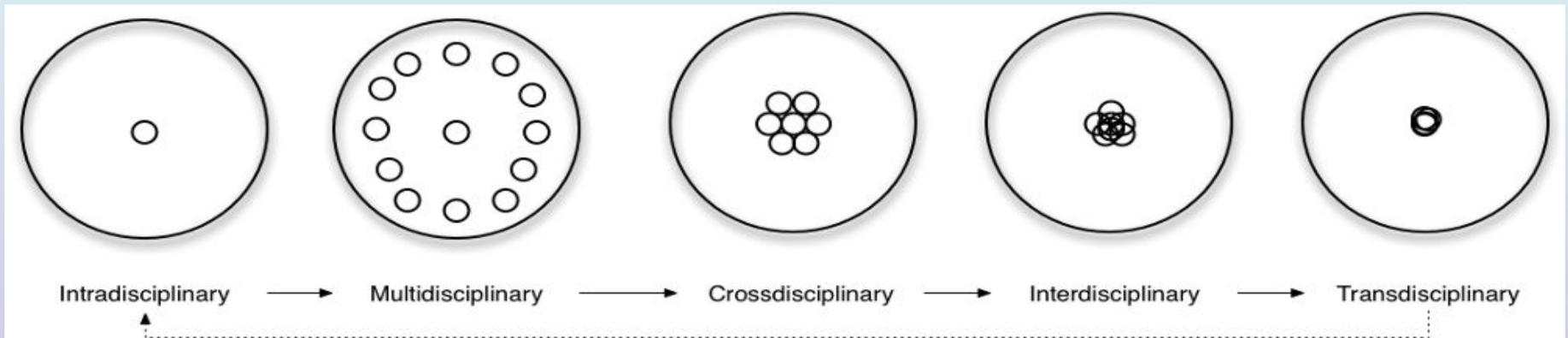
Core Questions of Sustainability Science

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- 1 How can the dynamic interactions between nature and society—including lags and inertia—be better incorporated into emerging models and conceptualizations that integrate the Earth system, human development, and sustainability?
  - 2 How are long-term trends in environment and development, including consumption and population, reshaping nature-society interactions in ways relevant to sustainability?
  - 3 What determines the vulnerability or resilience of the nature-society system in particular kinds of places and for particular types of ecosystems and human livelihoods?
  - 4 Can scientifically meaningful ‘limits’ or boundaries be defined that would provide effective warning of conditions beyond which the nature-society systems incur a significantly increased risk of serious degradation?
  - 5 What systems of incentives structures—including markets, rules, norms, and scientific information—can most effectively improve social capacity to guide interactions between nature and society toward more sustainable trajectories?
  - 6 How can today’s operational systems for monitoring and reporting on environmental and social conditions be integrated or extended to provide more useful guidance for efforts to navigate a transition toward sustainability?
-

# Transdisciplinarity

As A Key Approach in the  
Development of Sustainability  
Science



[http://www.arj.no/wp-content/2012/03/interdisciplinary.png?source=post\\_page-----](http://www.arj.no/wp-content/2012/03/interdisciplinary.png?source=post_page-----)

Latin *intra* (prep.) “within, inside, on the inside” — working **within** the frame of a single, recognised discipline. The collaboration depends on how wide the discipline is and the specificity of the research problem. For example, an astronomy research project focussing on stellar evolution will mostly include astronomers from the same field, and collaborators will publish in similar journals.

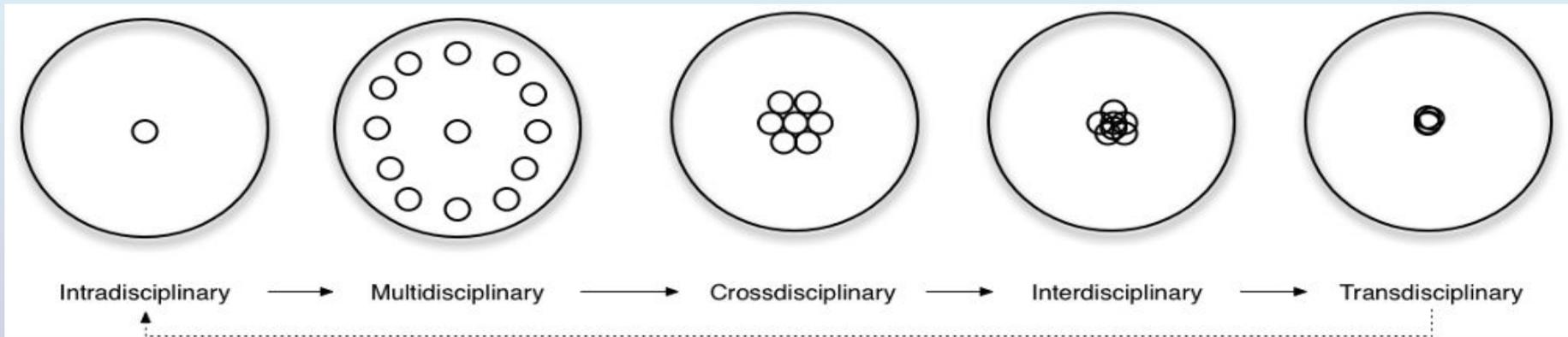
Latin *multus* (v.) “much, many” — looking at one problem by **adding multiple** perspectives and disciplines to the mix. In this process, a root discipline may involve other disciplines to solve a problem. Participants exchange knowledge and compare results, but stop short of integrating them. The disciplines maintain their distinctiveness and the results remain grounded in the framework of the root discipline. A multidisciplinary panel of business consultants, psychologists, lawyers and financial experts are common to resolve business conflicts.

What is ‘transdisciplinary’?

Words like multidisciplinary, interdisciplinary, and transdisciplinary are often used interchangeably. But what do they mean?

Jaya Ramchandani

<https://medium.com/we-learn-we-grow/what-is-transdisciplinary-13c16eacf57d>



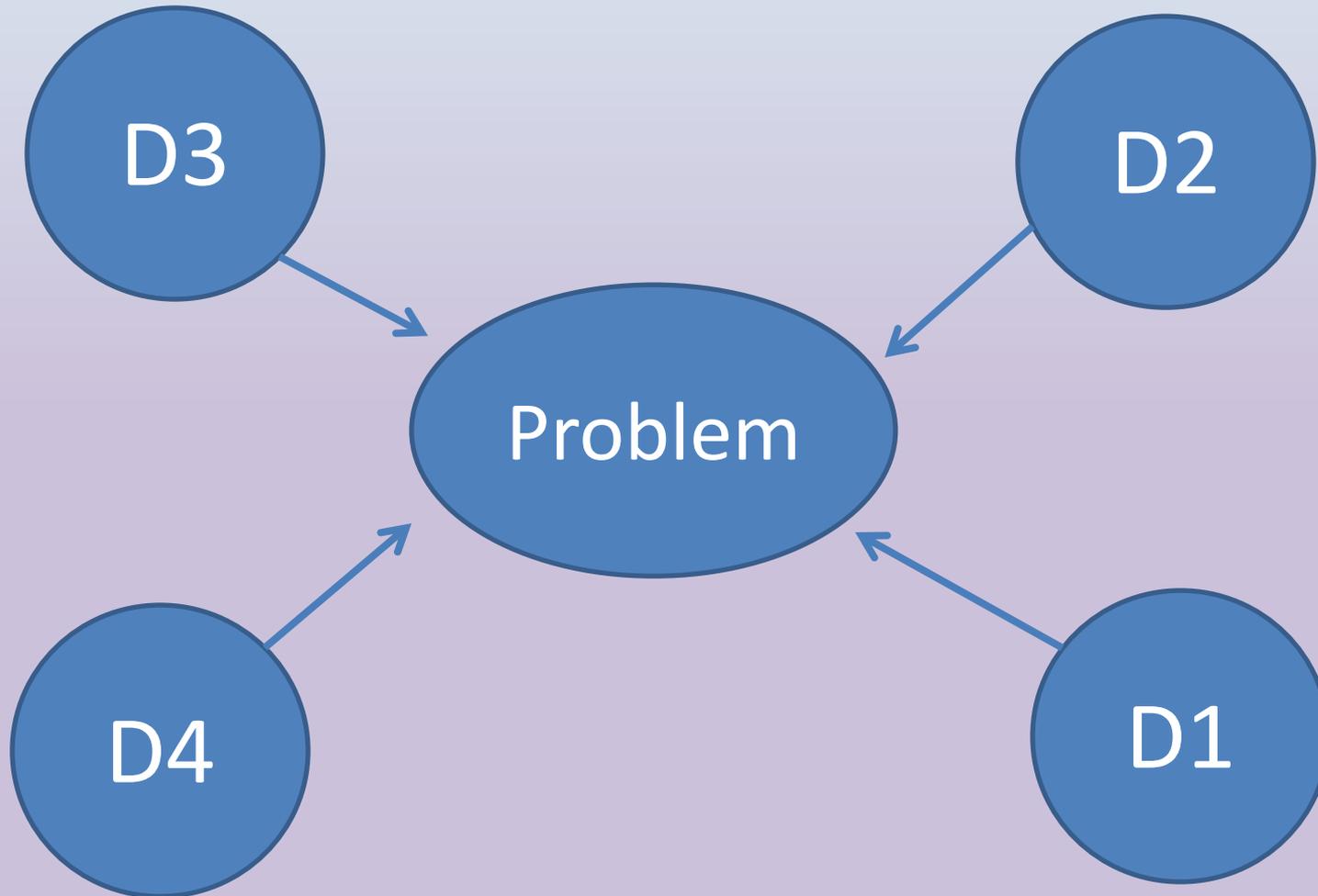
[http://www.ari.no/wp-content/2012/03/interdisciplinary.png?source=post\\_page-----](http://www.ari.no/wp-content/2012/03/interdisciplinary.png?source=post_page-----)

Latin *crux* (n.) “intersecting, lying athwart each other” — **intersecting** knowledge from two or more disciplines, viewing one discipline from the perspective of another. Researchers collaborate with the goal of **transferring** knowledge from one discipline to another. Understanding the complex dynamics of environmental problems in a socioecological context is a typical cross-disciplinary approach. Or combining tools from economics and philosophy to introduce an ethical dimension to the discussion of economic problems. Tress et al. (2005a) uses ‘crossdisciplinary’ more generally to refer to multi-, inter-, and transdisciplinary projects.

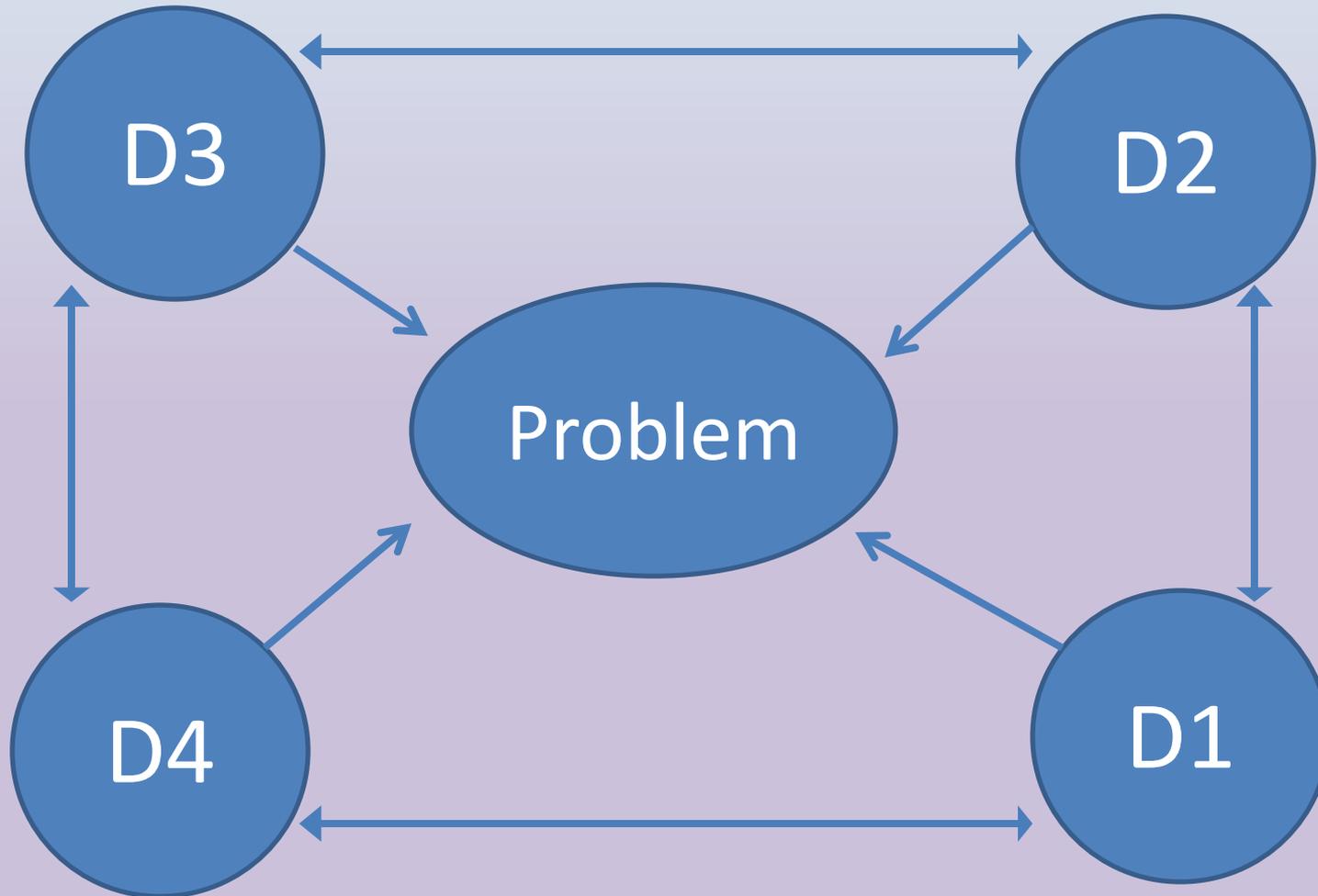
Latin *inter* (prep., adv.) “among, between, betwixt, in the midst” — **integrating** knowledge and methods from different disciplines using a **synthesis** of approaches. Interdisciplinary concerns collaborations between contrasting academic disciplines or research methods for new applications, new analyses, or the creation of entirely new disciplines (Nicolescu 1997). For example, interdisciplinary research on information systems and biomedical research has given rise to the field of bioinformatics. ‘Art & Science’ or ‘Art & Technology’ are hot interdisciplinary spaces in my line of work.

Jaya Ramchandani, *What is ‘transdisciplinary’? Words like multidisciplinary, interdisciplinary, and transdisciplinary are often used interchangeably. But what do they mean?*

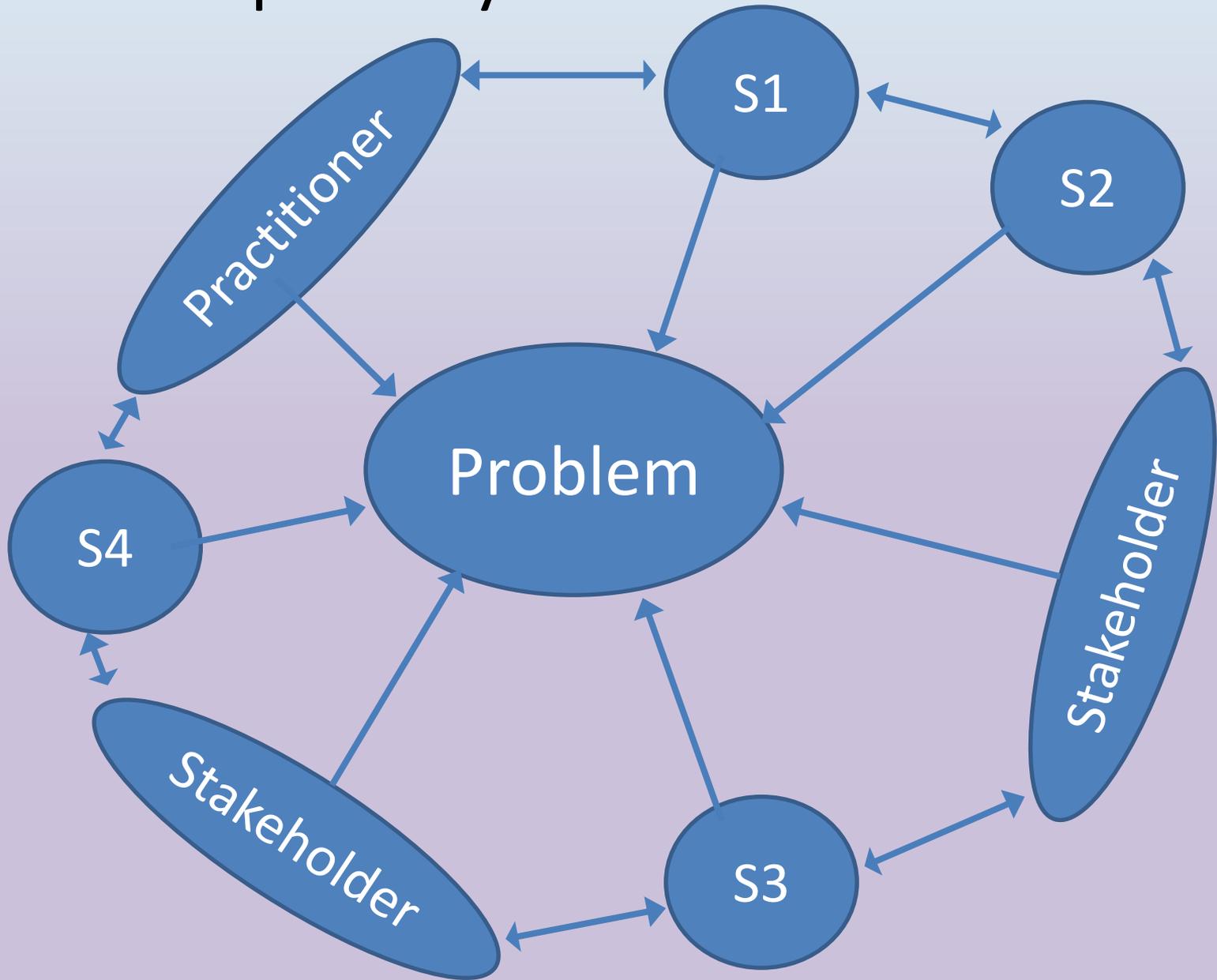
# Multi-disciplinarity

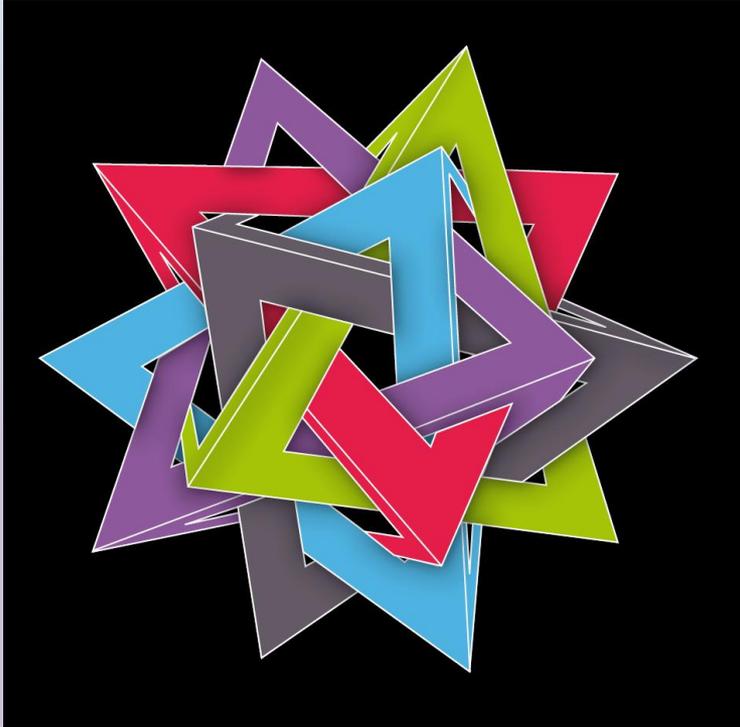


# Interdisciplinarity



# Transdisciplinarity





TRANSDISCIPLINARY (adjective)

<https://www.merriam-webster.com/dictionary/transdisciplinary>

Latin *trans* (prep.) “across, over, beyond” — emergence of a new discipline **transcending** the boundaries of disciplinary perspective. Transdisciplinarity **combines interdisciplinarity with a participatory approach**. The research paradigms involve non-academic participants as (equal) participants in the process to reach a common goal — usually a solution to a problem of society at large. It can be considered as the culmination of interdisciplinary efforts. Transdisciplinary also has a wholism associated with it. While interdisciplinary collaborations **create new knowledge synthesised** from existing disciplines, a transdisciplinary team **relates all disciplines into a coherent whole** (McGregor, 2004). The field of ‘sustainability’ in essence is a transdisciplinary one.

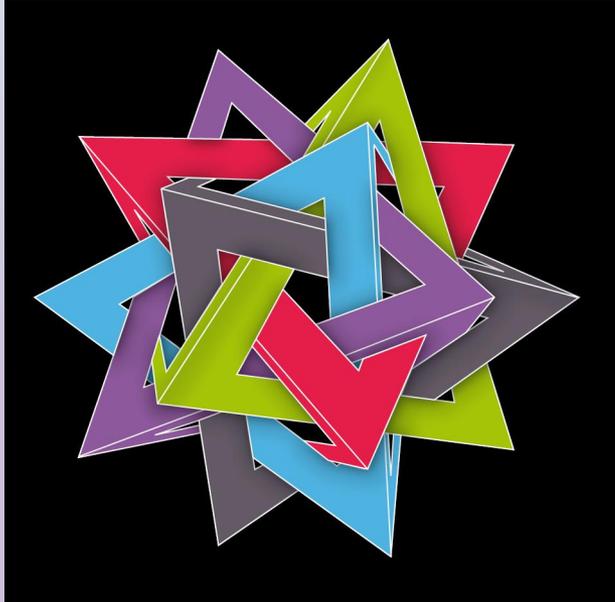
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# TRANSDISCIPLINARITY

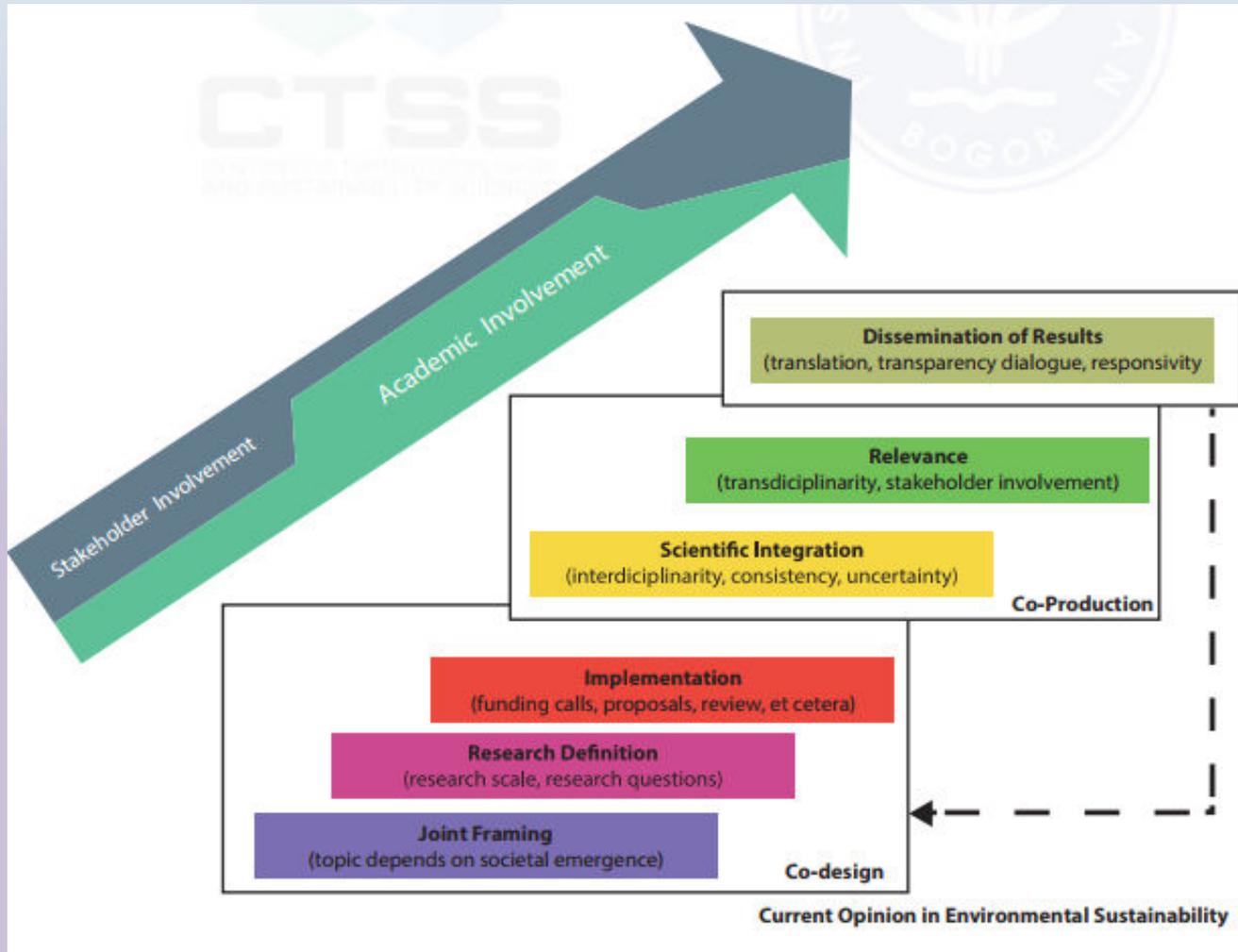


**Transdisciplinarity** connotes a research strategy that crosses many [disciplinary](#) boundaries to create a [holistic](#) approach. It applies to research efforts focused on problems that cross the boundaries of two or more disciplines, such as research on effective [information systems](#) for [biomedical research](#) (see [bioinformatics](#)), and can refer to concepts or methods that were originally developed by one discipline, but are now used by several others, such as [ethnography](#), a field research method originally developed in [anthropology](#) but now widely used by other disciplines. The Belmont Forum <sup>[1]</sup> elaborated that a transdisciplinary approach is enabling inputs and scoping across scientific and non-scientific stakeholder communities and facilitating a systemic way of addressing a challenge. This includes initiatives that support the capacity building required for the successful transdisciplinary formulation and implementation of research actions.

Wikipedia

<https://en.wikipedia.org/wiki/Transdisciplinarity>

# Ko-kreasi sebagai proses fundamental



Gambar 2. Kerangka kerja ko-kreasi memperlihatkan proses-proses yang terjadi, peran stakeholder untuk menghasilkan pengetahuan baru. Dikutip dari Mauser et.al. 2013.

# TRANSDISCIPLINARITY METHODOLOGY

## The three pillars

Transdisciplinarity without methodology is only a frivolous talk, a momentary fashion.

The methodology should be open, not dogmatic.

The methodology is based on the three pillars:

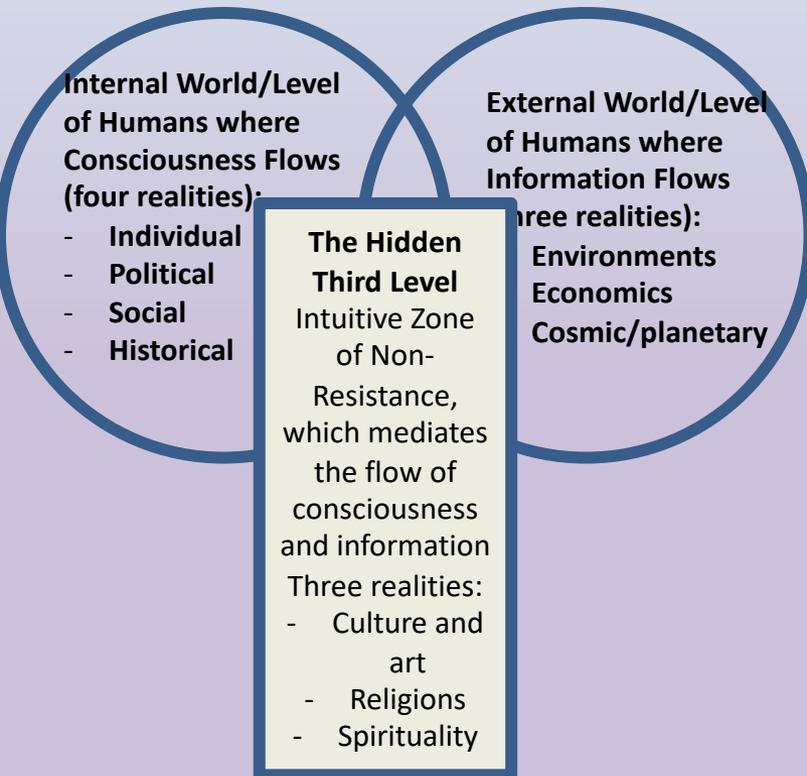
1. The various levels of Reality (ontological axiom)
2. The Logic (logical axiom)
3. Complexity (epistemological axiom)

Nicolescu, *International Congresses on Transdisciplinarity: Their Importance for the Emergence of a Transdisciplinary Methodology*, Transdisciplinarity and Sustainability, TheAtlas Publishing, Lubbock, 2012.

Epistemology is understood to be complex, emergent knowledge. Reality (ontology) is presumed to comprises Level of Reality (perspective and world views) mediated by the Hidden Third. The logic of inferences is called the Logic of Included Middle, the fertile middle ground of space among disciplines and between the academy and civil society.

McGregor, *Place and Transdisciplinarity*, Transdisciplinarity and Sustainability, TheAtlas Publishing, Lubbock, 2012.

## Multiple Levels of Reality (ontological axiom)



Nicolescu proposed it is essential to seek multiple perspectives on human problem (or set of human problems) because the intent is to integrate many levels of truth while generating new TD knowledge. Succinctly, TD ontology respects the complex and dynamic relationships among at least 10 different realities organized along three Levels of Reality:

- a. The internal world of humans, where consciousness flows – the TD-Subject (comprising political, social, historical, and individual realities);
- b. The external world of humans where information flows – the TD-Object (comprising environmental, economic, and cosmic/planetary realities)
- c. The Hidden Third, peoples’s experiences, interpretations, descriptions, stories, representation, images, and formulas meet on this third level. Three realities exist in this intuitive zone of non-resistance this mediated interface: culture and art, religions and spiritualities.

Together, the three overarching Levels of Reality form TD ontology.

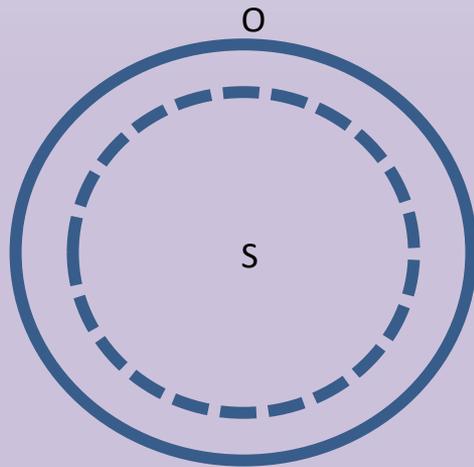
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# TRANSDISCIPLINARITY

## A history of the relation of Subject - Object

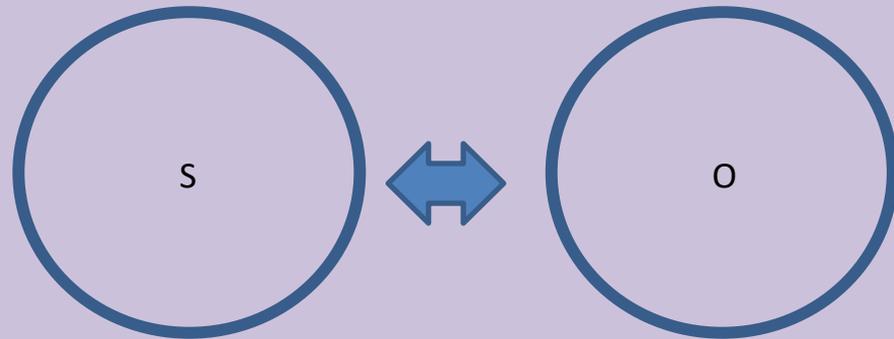
### Pre-Modernity

Subject is immersed in the Object.  
Everything was trace, signature of a  
higher meaning.



### Modernity

Subject and Object were totally separated by a radical epistemological  
cut, allowing in such a way the development of modern science. The  
Object was just there, in order to be known, deciphered, dominated, and  
transformed

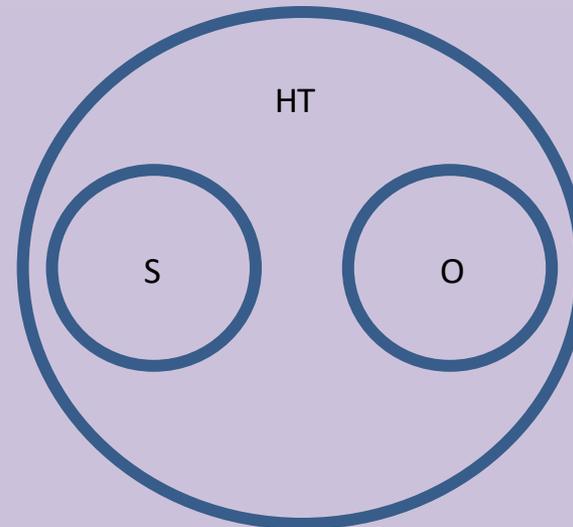
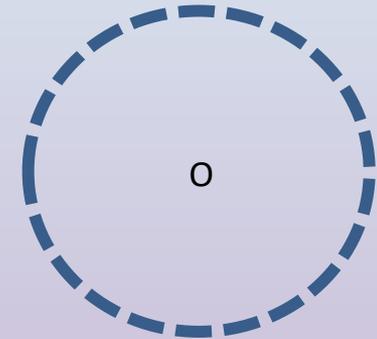
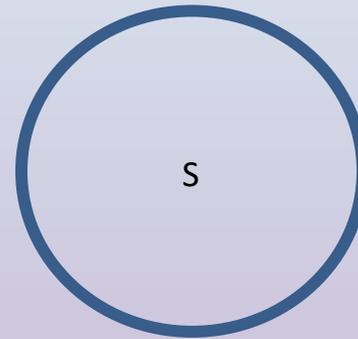


## TRANSDISCIPLINARITY

### A history of the relation of Subject - Object

#### Post-Modernity

In Post-Modernity the roles of the Subject and Object are changed in comparison with Modernity and are reversed in comparison with Pre-Modernity: the Object, still considered as being outside the Subject, is nevertheless a social construction. It is not really "there". It looks more like an emanation of the Subject.



HT = Hidden Third

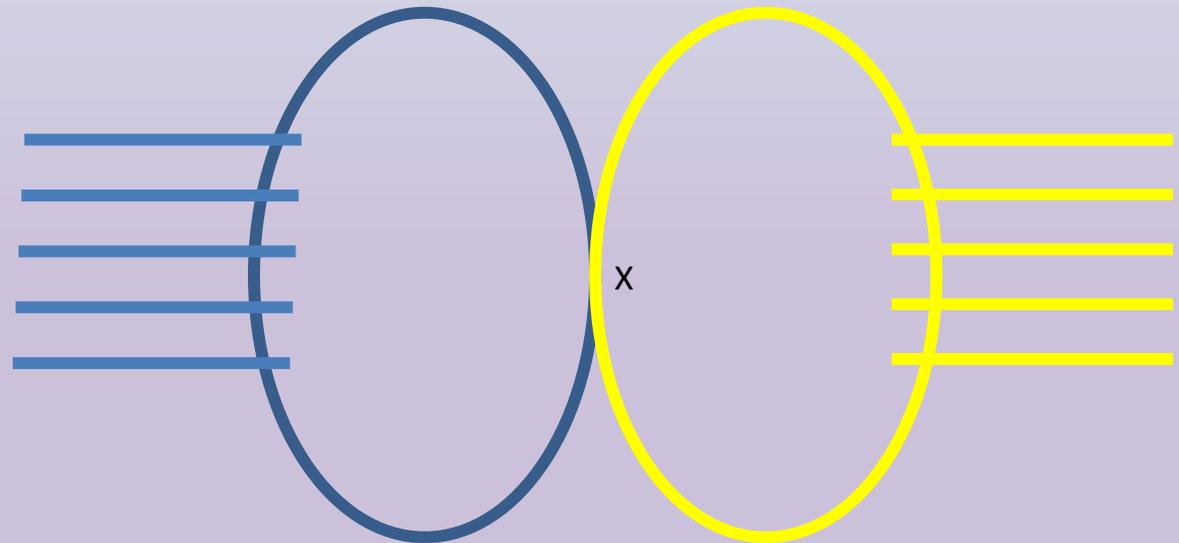
TRANSDISCIPLINARITY

## TRANSDISCIPLINARITY

### Transdisciplinary Reality

Transdisciplinary Reality  
The transdisciplinary Object and its levels of Reality, the transdisciplinary Subject and its levels of perception, and the Hidden Third define the transdisciplinary model of Reality. Based on this ternary structure of Reality, we can deduce other ternaries of levels that are extremely useful in the analysis of concrete situations by contextualization:

- Levels of organization – Levels of structuring – Levels of integration
- Levels of knowledge – Levels of understanding – Levels of being



## Complexity (epistemological axiom)

There are several theories of complexity. In the context of our discussion, it is important to understand that the existing theories of complexity do not include either the notion of levels of Reality or the notion of zones of non-resistance. However, some of them, like that of Edgar Morin, are compatible with these notions. It is therefore useful to distinguish between horizontal complexity, which refers to a single level of reality, and vertical complexity, which refers to several levels of Reality. It is also important to differentiate between transversal complexity and vertical, transdisciplinary complexity. Transversal complexity refers to the crossing of different levels of organization at a single level of Reality. From a transdisciplinary point of view, **complexity is a modern form of the very ancient principle of universal interdependence.**

# The Logic

The incompleteness of the general laws governing a given level of Reality signifies that, at a given moment in time, one necessarily discovers contradictions in the theory describing the respective level: one has to assert A and non-A at the same time. However, our habits of mind, scientific or not, are still governed by the classical logic, which does not tolerate contradictions. The classical logic is founded on three axioms:

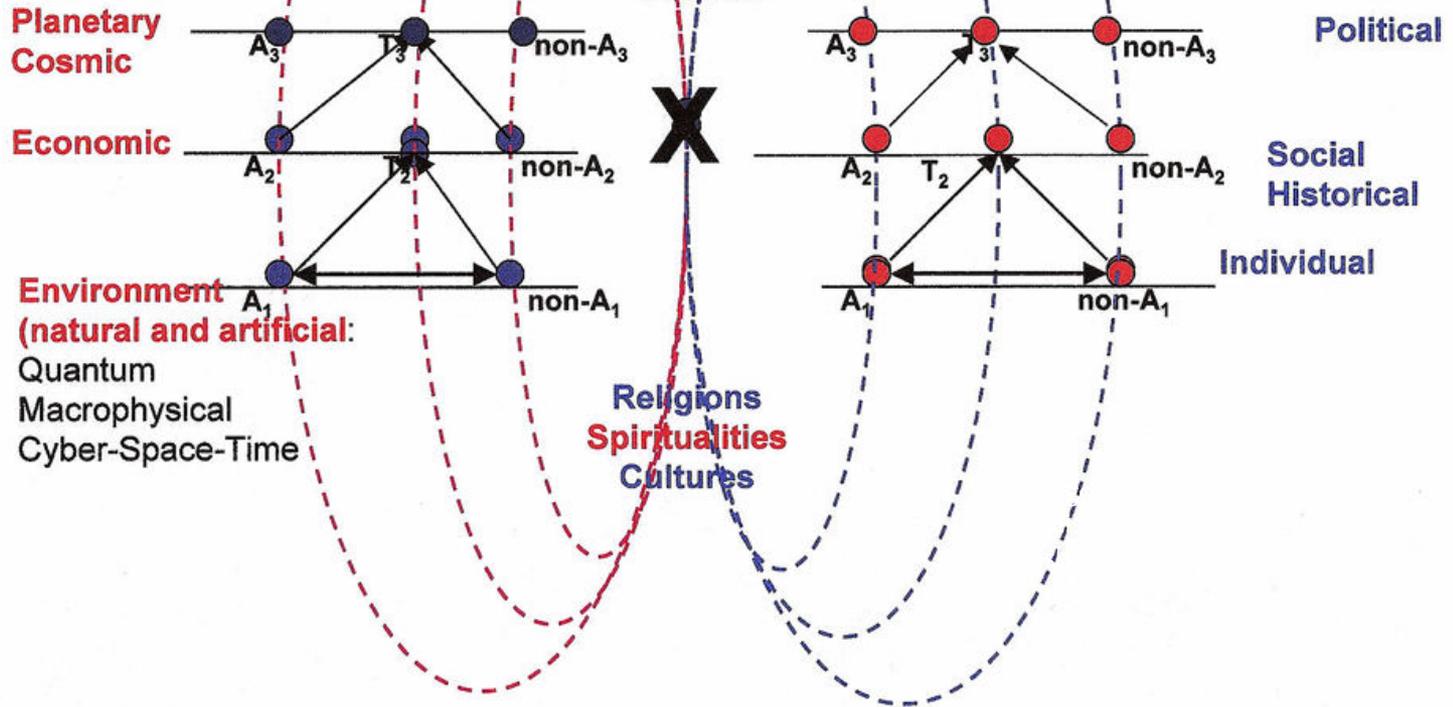
1. The axiom of identity: A is A.
2. The axiom of non-contradiction: A is not non-A.
3. The axiom of the excluded middle: There exists no third term T (“T” from “third”) that is at the same time A and non-A.

Stéphane Lupasco (1900–1988) demonstrated that the logic of the included middle is a true logic, mathematically formalized, multivalent (with three values: A, non-A, and T) and non-contradictory.<sup>6</sup> Our understanding of the axiom of the included middle — there exists a third term T that is at the same time A and non-A—is completely clarified once the notion of “levels of Reality,” a notion absent in Lupasco’s work, is introduced. In order to obtain a clear meaning of the included middle, let us represent the three terms of the new logic—A, non-A, and T—and the dynamics associated with them by a triangle in which one of the vertices is situated at one level of Reality and the two other vertices at another level of Reality. The included middle is in fact an included third. If one remains at a single level of Reality, all manifestation appears as a struggle between two contradictory elements. The third dynamic, that of the T-state, is exercised at another level of Reality, where that which appears to be disunited is in fact united, and that which appears contradictory is perceived as non-contradictory. Of course, this conciliation is only temporary. The action of the logic of the included middle on the different levels of Reality induces an open structure of the unity of levels of Reality. Knowledge is forever open. <sup>6</sup> Stéphane Lupasco, *Le principe d’antagonisme et la logique de l’énergie*: P

# TD REALITY

TD OBJECT

TD SUBJECT



# Key Characteristics of Transdisciplinary Research

- Orientation on actors/stakeholders (e.g. Practitioners, communities)
- Connection to practice – life world problem identified with stake holders
- Cross sectoral character
- New knowledge –anchored in life world of those affected by problem. Knowledge relevant to:
  - Scientists
  - Practitioners
  - Society

Bergman, 2005 Pohl and hadorn 2006 In: Oikodrom,  
<http://www.oikodrom.org/>

# Transdisciplinary Knowledge

KEY QUESTION	TYPE OF KNOWLEDGE	EXAMPLES OF SOURCES OF KNOWLEDGE
How are things now?	Systems knowledge	Disciplinary specialists, practitioners previously/currently working in area, existing literature, local communities and interest groups
How would we like them to be in the future?	Target knowledge	Community values and priorities, governmental officials and relevant governmental policy and planning documents other stakeholders (e.g. business representatives) scientific specialists
What strategies and actions are needed to facilitate a transition to this desired future state?	Transformation knowledge	Local communities, disciplinary specialists Practitioners currently/previously working in the area (e.g. development planners, engineers)

# Local Knowledge and Sustainability Science



Water Reservoir



The Landscape

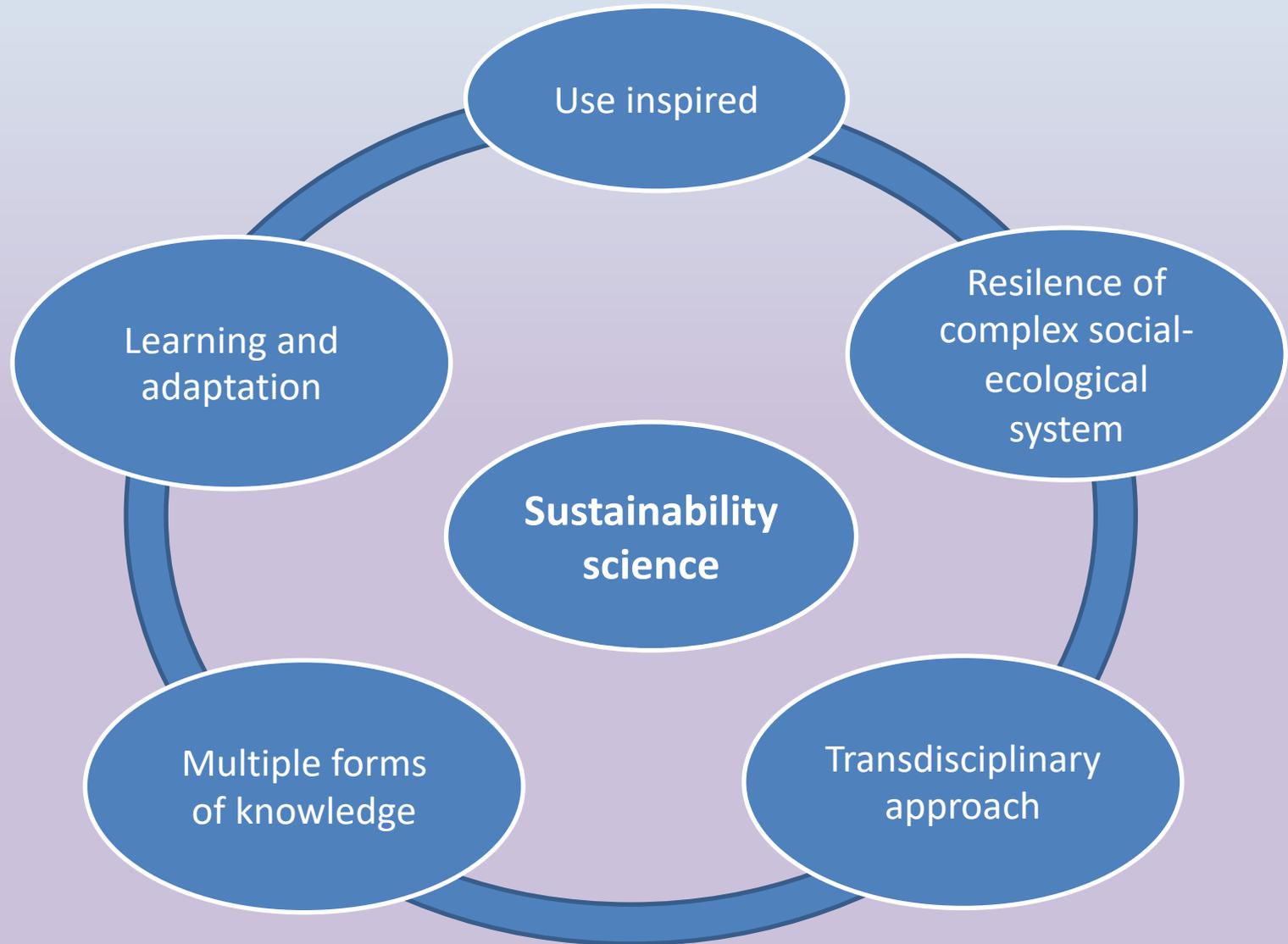


The Landscape

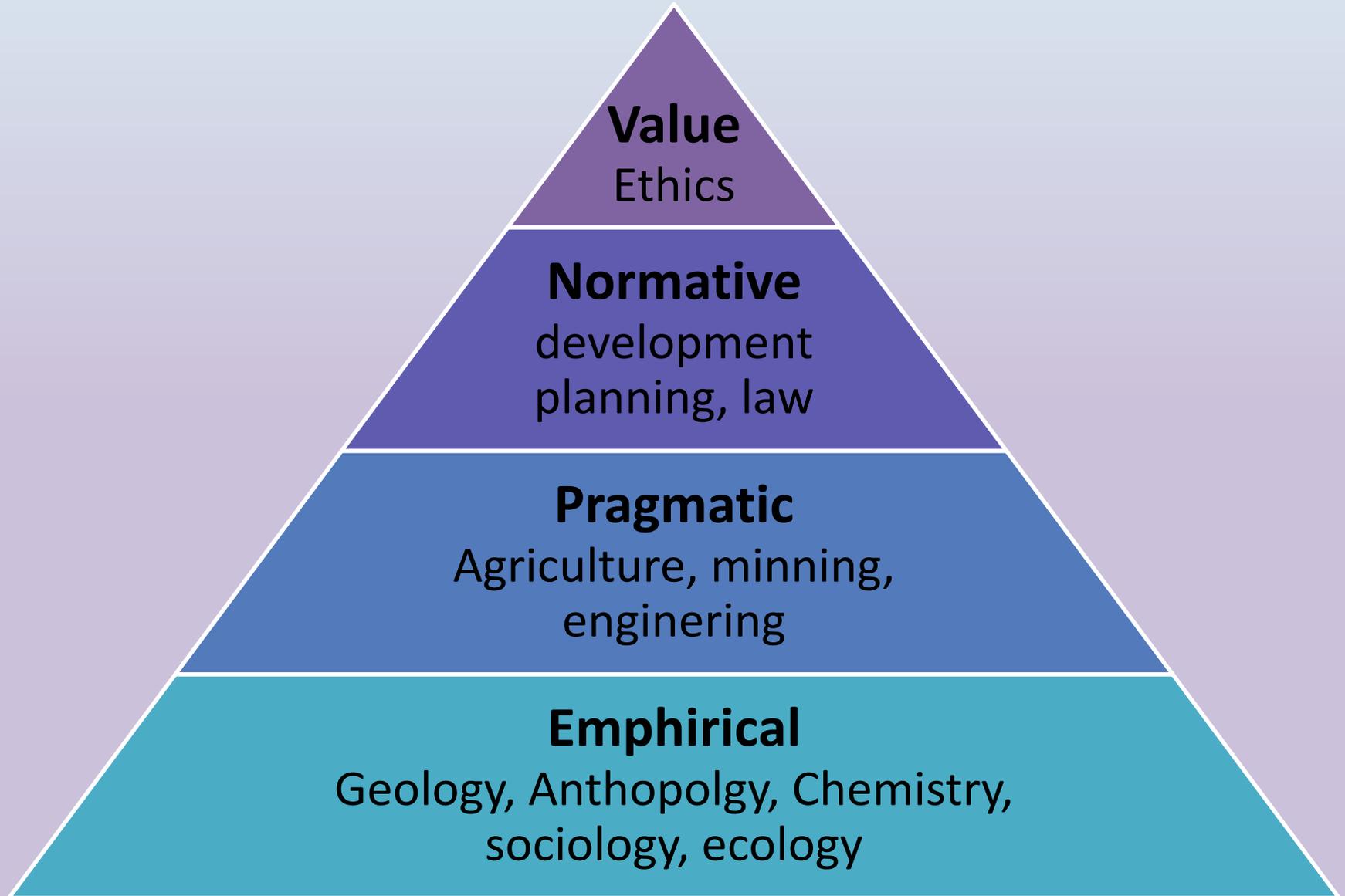
- Ritual of *Sasi*:
- Harvest



# What is sustainability Science



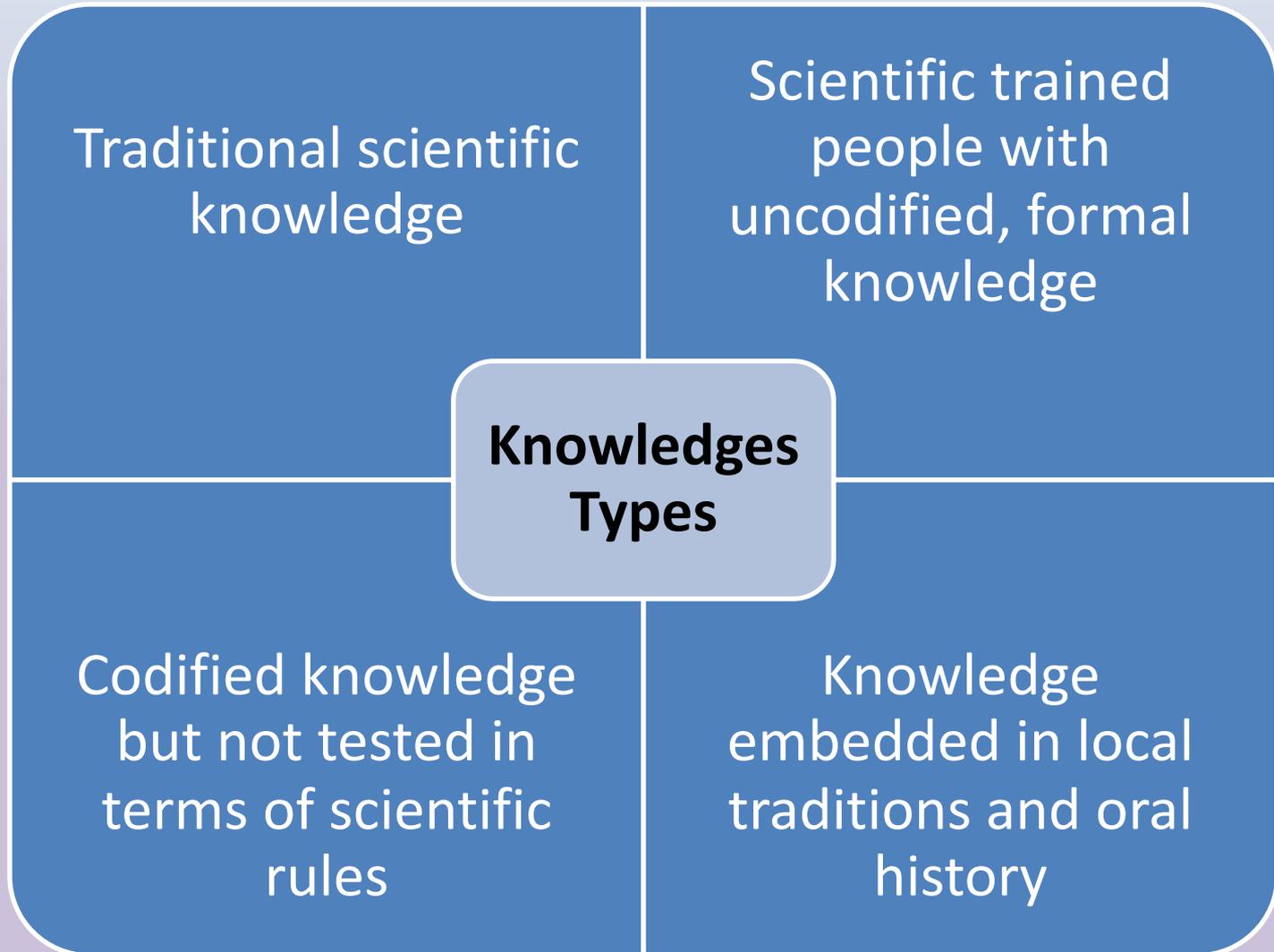
# What is transdisciplinarity



# INTEGRASI SUSTAINABILITY SCIENCE KEDALAM KURIKULUM PENDIDIKAN TINGGI: TANTANGAN

- Di design sebagai monodisiplin
- Q: apakah bias mengakomodasi perubahan paradigma: menekankan pentingnya **pendekatan sistem** serta menekankan pentingnya **interaksi-interaksi yang feasible antara system alam dan system manusia (between natural and human systems, Clark and Kates,2008).**

# Multiple Knowledge Types



# INTEGRASI SUSTAINABILITY SCIENCE DALAM KURIKULUM PENDIDIKAN TINGGI: TANTANGAN

Integration of different Knowledge Systems: How can it be done?

<b>Indigenous Knowledge</b>	<b>Western Scientific Knowledge</b>
qualitative	quantitative
intuitive	rational
holistic	reductionist
moral, spiritual	supposedly value-free
considers “mind” and “matter” together	mechanistic
based on empirical observation	based on experimentation and systematization
generated and held by the users themselves	generated by specialists
diachronic (long-time series of information on one locality)	synchronic (short-time series over a large area)

# Thus the integration of the two knowledge systems faces a number of barriers

- **Different perspectives:**

There is frequently a distinct difference in what Indigenous peoples think are significant impacts and what policy makers and those in favour of development projects think are significant impacts. These differences are probably rooted in both the habits of mind and the practical priorities of each group.

- **Scientific scepticism:**

Scientists are sceptical about the credibility or reliability of indigenous knowledge gathered through interviews, preferring “hard” data such as biophysical data. Some may dismiss traditional knowledge as subjective, anecdotal, and unscientific.

- **Politics:**

Policy makers may resist altering established decision-making processes to accommodate the use of science-based/evidence, for reasons having to do with an interest in controlling the process.

# Developing capacity building in sustainability science

- Skills building initiative:
  - ✓ Development of core training modules, incl. methods, case studies, exercises, M+E component
  - ✓ Adaptable to context, topics, and audiences
  - ✓ Trainings in different countries and regions
  - ✓ Development of an international pool of trainers
  - ✓ Web-based platform of resources

Terimakasih