Vision

ENVRI Strategy

In the ENVRI project, it came clear that a common plan is needed to ensure a concerted development of the European Research Infrastructures in the future. The European Environmental Research Infrastructures Strategy (ERIS) was thus a major product of the project and led to more strategic collaboration between the participants. An updated version of the strategy is now being developed within the ENVRIplus project. This activity is led by Finnish Meteorological Institute.

Vision of the strategy

The ENVRI community defined in its **ERIS strategy** common aims and goals for the future:

The vision for environmental research infrastructures for 2030 is aiming towards universal understanding of our planet and it's behavior. This should result in the evolution of a seamless holistic understanding of the Earth System, an environmental system meta-model, a framework of all interactions processes within the Earth System, from solid earth to near space. Scientists that within their own science contribute with data, models, instruments, algorithms and discoveries should feel that this serves a greater good, namely a contribution to this understanding.

This holistic understanding will make it possible to approach the entire Earth System from different perspectives, and chose the portions of the whole conceptual understanding which are relevant to the problem to be solved. This approach makes it possible to do new and flexible services, answer environmental and societal challenges. Most importantly this approach is also aiming to be complete: Any emerging issues can be tacked on the framework of this understanding, enabling tuning and improvement of the understanding and building the connections to other scientific fields, such as social sciences.

Environmental Sciences are rapidly moving to become one system-level science, mainly because modern science, engineering and society are increasingly faced with complex problems that can only be understood in the context of the full overall system they belong to. There are several reasons and enablers for this shift:

- **Technology push.** Technology innovations on, for instance, detectors and sensors with ever increasing resolution, allow deep observations of scientific phenomena important for the better understanding of a whole system. A connection between these new observations to the whole Earth System requires ways to integrate between the domains. In addition, information technology innovations, such as digitalization of collections, also unlock resources at a systems-level.
- **Demand pull.** The questions scientists are faced with nowadays (not only arising from curiosity, but also from policy like IPCC, IPBES and GEO/GEOSS and societal needs) can simply not be solved using the traditional sources of information. Without access to information from adjacent disciplines, the answers scientists can give will increasingly be partial and incomplete, and therefore less groundbreaking or even useful.
- Like in economics and society, science is experiencing an up-scaling due to globalization. Establishing and managing big data and information repositories often demand an international effort. This can also be observed from the ever-increasing aggregation of research funding, such as ESFRI.
- **Resource integration.** Never before did researchers of so many domains have such a wealth of resources at their disposal. The integration of these worldwide available resources has further fueled system-level research. An important contribution of e-Science as a system- level science is its potential for integration of information.
- **Science Integration.** These developments in science in general offer an excellent opportunity to approach the Earth as an integrated system, with an eye out to related sciences, such as social sciences and life sciences.

Actions and suggestions

The vision requires understanding and a conceptual model that is capable of providing a definitive answer, which is reliable and credible. However, building such an integrated view is not straightforward. Development of this view requires resources, and we identified 3 interdependent sources of resource capital, which need to be improved to achieve this vision:

Technological Capital: Capacity to measure, observe, compute, and store. This requires material, technologies, sensors, satellites, floats; software to integrate and to do analysis and modeling and processing; building observational, computational and storage platforms and networks.

Cultural Capital*:* Open Access to data, services etc. from other research infrastructures. This requires rules, licenses, citation agreements, IPR agreements, technologies for machine-machine interaction, workflows, metadata, data annotations etc. The goal should be to contribute always to the standard understanding, the systems approach; research infrastructures work together as a community on the policy level.

Human Capital: specialists to make it all work. This requires both data scientists and discipline scientists. The need of disciplinary specialists is not going away, but answering the societal and environmental challenges needs experts capable of truly inter- and transdisciplinary science, working between the typical scientific boundaries. This also calls for 'generalists' that oversee more than just their own discipline. These specialists need their own curriculum and training. Additional human capital need comes from the challenges to include and train citizen scientists.

> **A term model here is not to mean a* computational model*, even though that can be one realization. Here the term is meant to describe a self-contained and consistent contextual model, which describes our understanding of the system, its linkages, and feedbacks.*