3.2 SIX AXES DESCRIPTION AND RELATED TRANSDISCIPLINARY PROJECTS

3.2.1 Axis 1: Analyse water, actors and Territories trajectories

Water within territories is the result of complex interactions between humans and ecosystems. Understanding water trajectories within territories implies a thorough eco-systemic approach including their past construction, the various human activities, the evolving modes of regulatory and governance as well as the ecosystem functioning and observation.

① Multiple values of water

The value of water should not be reduced to the economic value of water uses for human activities. The recognition of the intrinsic value of water and the diverse representations influence the management of this common good use, as well for biodiversity and ecosystem services. This plurality of values, ethical and cultural references and other normative categories, influence the process of decision-making and the process of legal recognition for human rights to water and to socio-environmental justice. Based on cases studies as for the following items, we intend to compare the specific local, regional results and to link them, in particular with the European policies and Laws debate.

② Regulation & governance of water protection and uses

The 2030 Agenda for sustainable development reiterates the urgency of ensuring availability and sustainable management of water and sanitation for all. Attaining such goal requires reinforcing an integrated environmental approach (water cycle, biodiversity, soils, climate change (...) and its effective implementation. It also implies to further strengthen the environmental consistency of public policies as agricultural, industrial or urban planning (…). In the light of the citizen European initiative “Right to water”, innovative modes de regulation and adaptive legal framework are expected at different levels of governance. It calls for new partnerships between scientists, decision-makers and stakeholders, in particular the public. It’s also invite to experiment the use of nature based solutions and green infrastructures for sustainable water future.

③ Water observation and experiments

Emerging sensing technologies open a new window on the temporal dynamics and spatial structure of environmental resources, fluxes and interfaces (soil/atmosphere, river/groundwater). Monitoring the pulsations of fluid flow, chemical elements transport and reactivity within the critical zone is paramount to uncovering interactions and feedbacks and quantify water, mass and energy fluxes through environmental systems.

Understanding and quantifying reaction-time and trajectories of complex environmental systems under climatic and anthropogenic pressures (or relaxation) represents a daunting scientific challenge. RSEI will focus on three emblematic projects on well-instrumented sites - a large dam removal, the establishment of a new groundwater pumping station and the urbanization of a floodplain - to quantify the long-term biophysical and socio-economic evolution of their environment and refine our understanding of both environmental system and drivers.

④ Water resource management in urban and peri-urban areas

Urban and peri-urban areas present specific problematics. Within cities, water management intersects with urban planning and building norms and conception. Water flows and infiltration of water have to be reconsidered as well as water uses. Peri-urban areas are the main locations of water resources used in cities thus creating potential social and political conflicts and needs for integrated management and protection. Furthermore, global changes impact previous water resource.

⑤ Protect coastal areas

Coastal areas are the location of major human pressure and are exposed in particular to diverse land-based pollution. According to the European Water Framework Directive, the water cycle needs to be taken into account (inland surface waters, transitional waters, coastal waters and groundwater) and with climate change, the coastal areas are specifically impacted by climate change with severe economic consequences. These areas are impacted by sea-water level increase but also by the potential modification of aquifer functioning that may drive either flooding or drought depending on the considered area.

Partners: Almost all partners.

3.2.2 Axis 2: Towards Agroecology

Agricultural models need to evolve towards new production systems within diversified territories to reconcile their objective of food security with nature and human health. Agroecology has particularly to protect water quality and environment health. It can help to design sustainable agroecosystems targeting responsible agriculture by combined sciences of ecology, agronomy, and social sciences. Building on ecosystem services, the agro-ecological transition suggests generic research questions on the functioning, resilience and management of terrestrial and aquatic ecosystems in combination with agroecosystems which have to remain competitive.

Links between natural resources (water, air, soil), biodiversity and agriculture will be investigated at four relevant scales:

① From the individual (plant, animal) to the field (herd)

The main issues at that scale are a better understanding of the interactions between soil, plants and biodiversity in order to improve plant resistance to diseases or stresses and to favour plant nutrition with less mineral fertilizers. For animals, issues are linked to improvements of the individuals (while maintaining high genetic diversity) and of the animal wellbeing.

② the farm

At the farm scale, the research will focus on the design of innovative and resilient production systems based on ecosystem services delivery and requiring less non-renewable resources, e.g. water resources. Economic and social conditions enhancing transition to multi-performance agricultural systems will be explored.

③ the territory

Synergies between agricultural systems at territory level will be explored in terms of biophysical interactions and also through the socio-economic conditions and organization developing these synergies. The link between agriculture and other activities will be considered in order to improve the global sustainability of the territory, asking agriculture to decrease its environmental impact while maintaining food production and improving other services (recycling, biodiversity, etc.).

④ the landscape and the ecosystem services

The landscape will be considered as a co-construction between human and society and the concepts of landscape ecology and associated ecosystem services will be further explored. Special attention will be given on how the spatial organization of natural and agricultural areas can favour biodiversity and ecosystem services and how water management can be improved when considered at landscape scale.

Partners: Regional authorities, agriculture structures, env. offices., private partners, associations

3.2.3 Axis 3: Reduce pollutant exposure

Huge gaps exist between the collection of pollutant (pesticide residues, endocrine disruptors, antibiotics, volatile organic compounds, plastics, particles and nanoparticles) data in surface and groundwater and their use to evaluate environmental and human risks. Ecological and sustainable alternatives, tools for assessing hazards and risks do not cover the full spectrum of the molecules of interest. Preventing their dissemination in the environment requires action by the entire industry and population, from the production / substitution of the incriminated molecules, their usage / treatment in society, the assessment and measurement of their fate in the environment, the assessment and measurement of their impact on the environment and human health.

Solving the question of reducing exposure to pollutants needs to integrate the risk chain from upstream to downstream of our lifestyle with a precise representation of the total flow and risk behavior analyses including controversy, ethics, lobbying, sociological expertise, acting, and social determinants.

The researches will target on 5 specific topics.

① Characterize the sources of pollutants and promote substitution or remediation

RSEI scientists will develop sensors and work on tools to observe the environment and analyze pollutants in various matrices as well as their release mechanisms. Then the objective will be to identify the various pollutant sources of the territory to better reduce them at all possible levels via the promotion of green chemistry or agroecology, as well as when necessary the optimization of waste treatment and management. Ecosystem services and nature-based solutions will also be explored.

② Analyze the contaminations of surface and groundwater, and the environment

The object will be to analyze the exposure routes and transfer mechanisms within water, and when required air and soil, of known pollutants (nitrates, pesticides, etc.), emerging pollutants (nano particles, drug residues, toxins), pathogenic and parasitic species. The development of biosensors and biomarkers will be explored.

③ Characterize exposures for human health

Scientific understanding of how external exogenous environmental exposures are related to individual endogenous exposures at the target organ level and the effects of these exposures on personal health outcomes and their potential impact on population health disparities is in its formative stages. We will combine data obtained on environmental intensities (for example, water quality) with motion, location and pollution sensor data to provide more detailed estimates of long-term real-time chemical, biologic, or physical exposures.

④ Assess and manage environmental risks

The assessment and management of environmental risks (= ecosystem health) is a leading edge research topic that requires the development of innovative methodologies and tools. We will promote such approaches to: (i) assess the health risks of ecosystems and environmental health, (ii) integrate the concepts of spatialization, biodiversity, quality of life and local impact into tools such as life cycle assessment or environmental footprint, (iii) minimize industrial impacts a priori by eco-design and modeling practices; and (iv) develop the concepts of repair and environmental responsibility.

⑤ Analyze human and ecological vulnerabilities to pollutants

We will develop transdisciplinary methods to help unravel the complex interactions between environmental stressors and bio-psycho-social systems at the individual, community, and social-ecological systems levels, as those relate to personal health and population level disparities. By explicitly recognizing the embedded nature of health outcomes within the biological, social, ecological, and community contexts, we will provide a better understanding of health disparities across socioeconomic and geographic boundaries that, to date, remain largely unexplained. We will analyze representations and communication issues in environmental controversies.

Partners: Water agencies, water treatment actors (Veolia, Saur, Suez); public actors (Rennes Métropole, ADEME), health agency (ANSES)…

3.2.4 Axis 4: Invent new participative strategies

Since the 1970s, many innovations have emerged to strengthen public participation in environmental projects and foster the co-construction of knowledge in environmental research. Participation is seen as a mean to make knowledge and projects more relevant to the public, in line with concrete needs and, thus, more legitimate. It should be stressed as well that local knowledge, based on experience and practice, often have to be taken into account in order to understand a specific environmental problem and the plausible solutions. Moreover, contemporary theory in environmental ethics prescribes a fuller integration in decision-making and knowledge development of actors representing forms of life and ecosystems that don't have a voice in environmental debates but are fundamentally impacted by human activity.

The concept of E.I. is thus based on the ideas of participation and co-construction. It explicitly implies the engagement of multiple actors and partners in the process of developing knowledge, solutions to environmental problems, and projects. Two goals will guide axis 4:

i) To develop new forms of hybridization of knowledge in order to respond to the great heterogeneity of environmental approaches (whether empirical, scientific or sensitive) and interests. While the classical forms of knowledge based on the idea of a distinction between object and subject, nature and culture, are more and more found to generate exclusion, the E.I. concept will foster the inclusion of actors and local and alternative knowledge.

ii) To develop new solidarities to build an inclusive socio-ecological transition. This can be done firstly through the reconnaissance of the identity and interests of actors and stakeholders, and the reconnaissance of the needs of life forms and ecosystems, and their representative in civil society. Secondly, participative methods will help translating and aligning these interest in order to imagine better sustainable futures and build new solidarities to promote them.

iii) To develop tools and methods for participative modes of research. Participative research methods – such as action research, participative modelling, transition experiments, etc. – will be at the core of the hybridization knowledge and the development of solidarities. These methods all have in common the principle of the co-definition of the research objectives and expected results. Even the analysis of data can be set in a participative manner. These methods are also expected to strengthen solidarity and long-term relationship between the partners, participants and researchers.

iv) To help the corporate sector in integrating a socially responsible philosophy. Corporate social responsibility can be thought of as a form of solidarity among actors of environmental problems. By helping the business sector and large organizations to integrate the environmental intelligence concept in the management and organizational philosophy, we hope to strengthen the overall idea of axis 4.

Partners: Regional and local authorities, water management (CRESEB, CEBR), participative env. offices (Derven, LGI, Cerur, Callige, Enviroscop), agriculture networks (CIVAM, Organic federation), NGOs (Les p'tits débrouillards, ATD Quart-Monde, ERB, Bretagne Env.)

3.2.5 Axis 5: Develop smart data and observations

The environment, and water systems in particular, can generate very large data bases and observations of various formats and semantics. This huge amount of data creates needs at various levels from their acquisition, treatment, quality assurance and use. The key challenge is to design new methods taking into account the data heterogeneity, and turn it into useful knowledge that enables better understanding of water systems and adaptations to meet environmental targets.

① Conceive the environmental open data

How to support environmental data democratization? The main challenge here is to study and define theoretical foundations and concepts of environmental open data governance (user interface design, metadata, open data infrastructures, semantic interoperability and ontologies, privacy issues, data management process, …).

② Data acquisition and captation

Develop techniques for acquiring data from a range of sources (drone, sensors, internet of things, crowdsourcing, …) and evaluate authenticity, accuracy and timeliness.

③ Searching information and knowledge within data

Provide users with means to dig through large amount of multidimensional and heterogeneous data, from more or less abstract viewpoints. In recent years, due to the Big Data revolution and the evolution of computing and data processing capabilities, major advances have been made in the field of AI, particularly in machine learning. This explains the rising popularity of this research field and a boom of its practical applications (smart agriculture, weather and climate prediction, smart transport options, etc.). The challenge here is to propose interactive and interpretable machine learning methods to mediate the communication between complex ML/AI systems and users.

④ Modelling and simulating

To understand complex ecological and environmental phenomena, we need to design computational models and implement simulators to test the system behavior under various parameters. Such models generate many intermediate results that should be managed, analyzed and transformed into usable information.

⑤ Restoring and visualizing data and knowledges

Data visualizations are key for helping people to explore and understand data sets. The key challenge here is to provide data-centric systems through which domain experts and individuals of varying skill levels can interactively analyze and explore large environmental data sets.

Partners: Regional and local authorities, water management (CRESEB, CEBR), water agencies, data and modeling companies (Itasca, Deltadore, Lacroix-Sofrel, Scheme, FouleFactory), associations (Bretagne Env.)

3.2.6 Axis 6: Co-construct models, scenarios and shared decisions

The co-construction of scenarios and shared decisions is the final goal of Research School of Environmental Intelligence (RSEI). Within this axis, we define the tools and approaches that have to be developed to support sustainable territory projects.

① Develop decision-support tools including feedback expertise

Decision support tools have to include stakeholder expertise. They are based on the following experiments :

- Capitalize the available knowledge: rely on a detailed knowledge of the territories with the help of the scientifics, user associations, socio-economic actors and citizen communities. Beside recognized expert knowledge, whether scientific or technical, it will be necessary to co-construct decision-support tools including different types of knowledge (empirical, sensitive, commonplace...). For that, these tools will be based on the integration of the cognitive dissonances of the actors.
- Identify territorial issues and set strategic objectives: limits of resources, impacts on populations, risk factors and opportunities; preserve the quality and quantity of resources and environments, ensure their availability and access in response to long-term needs for the environment and populations.

② Build predictions and prospective scenarios

The scenario method (MDS): defines and describes the possible scenarios to anticipate conflicting situations with stakes; collectively develop the sustainability criteria in a contractual framework and evaluation indicators (local Agenda 21, territorial charters, forest charters, natural parks, river contracts, etc.) and common rules (by planning: Plan Planning and Sustainable Development (PADD), Local Urbanism Plans (PLU), Territorial Coherence Schemes (SCOT)

Choice of the scenario and governance: The condition of success of the process consists of a real social and cultural local contract between the actors of the territory. This balanced and continuous conduct is based on a dialogue with all stakeholders and their representatives, and on the convergence of positions to make decisions by consensus.

③ Develop participation models and tools (see axis 4)

④ Develop sustainability models

The final development of sustainability models relies on an action-plan which allows experiment. It is followed by the action evaluation in an iterative process.

In that perspective, the sustainability is a value who gives a way, an outlook to build models. This value guide models defining what they should aim for. This outlook allows to modify the solidarities between the humans (those of today and future generations), but also between the humans and the other living (animals and plants) and "natural objects" like river, watershed, etc... The concrete operations, in the context of sustainability, will result from co-construction between stakeholders to define the shared sustainable future.

⑤ Integrate in the models environmental justice and democracy

The realization of environmental and social justice, fairness and global security are a sine qua non condition to meet the challenge of ecological transition and inclusive society in the light of the planet boundaries. Our research examines how the concept of environmental justice need to be designed and translated into concrete actions on the grounds at different spatial scales and decision-making levels. We will assess which values are at stake, how human individual and collective rights and obligations are or could be defined and implemented depending on the approach adopted (distributive, corrective …), how an equitable sharing responsibilities is designed, which kind of governance is proposed, how to promote the players' capabilities .

Partners: Regional and local authorities, Participative companies (LGI, TMO), associations (ATD Fourth World, Les p'tits débrouillards)…