INCLUSIVE groundwater

Project main results

Project partners

INCLUSIVE project is funded by the Belmont Forum under the Collaborative Research Action (CRA) Soils 2020

Result 1

The project led to the development and operational testing of various participatory methods designed to foster social learning regarding groundwater issues, as well as a method for evaluating this learning. The associated deliverables are presented in several working papers (WP) covering the state of the art (WP4), a framework for analyzing social learning (WP5), and an operational methodological guide (WP6).

Result 2

Participatory approaches foster cognitive learning, particularly concerning groundwater functioning and the conditions for sustainable management. In the Adour basin, participants' learning focused mainly on the groundwater resource itself, which was previously unknown to them due to its invisibility, geographic extent (19,000 km²), and depth (up to 800m). Exchanges between stakeholders and scientific experts allowed for the development of a shared understanding of its 3D geometry, hydrogeological functioning, and management challenges. This learning was strengthened by the sharing of practical knowledge from current users (water utilities, farmers, thermal baths). The absence of "knowledge asymmetries" helped create a sense of belonging to a user community that did not exist before.

In the Landes region, learning centered on climate change impacts and adaptation possibilities. This was a truly collaborative process where scientists facilitated the appropriation of model results, and stakeholders provided their own reading of potential socio-economic impacts and adaptation measures. This combined "heterogeneous knowledge" fostered a systemic understanding of the interactions between groundwater, lakes, rivers, wetlands, and forests.

In the Scott and Shasta Valleys (California), stakeholders gained an advanced mastery of scientific concepts despite persistent controversies regarding groundwater-rivers interactions and salmon protection issues. Conversely, in Yolo (California), cognitive learning was more uneven due to differences in participants' initial scientific skills. In Taiwan, workshops shifted the

perception of subsidence from a simple regulatory issue to a systemic problem linked to conflicting public policies, such as food security incentives and urban planning failures.

Result 3

Under certain conditions, the participatory use of hydrogeological models can foster social learning.

First condition: Providing stakeholders with the necessary knowledge to understand the model's functioning (assumptions, simplifications, scales). This involves training and capacity building so they can grasp modeling choices and contribute to scenario definitions, as seen in the Seudre basin and Scott Valley case studies.

Second condition: Building trust in the models so they are seen as faithful virtual representations of the invisible resource. In Scott Valley, this was achieved by integrating field observations and empirical knowledge from the stakeholders themselves, turning the model into a tangible result of knowledge co-production. The model then becomes a “boundary object”.

Third condition: Ensuring models answer concrete questions from stakeholders. This may require modelers to be creative, such as in the Landes case study where the modeler simulated drainage impacts with a tool that was not originally designed to do so, or in the Seudre basin where the model was used to simulate the impact on groundwater of land management Nature Based Solutions.

Result 4

Beyond cognitive learning, participatory approaches develop relational and political skills and can induce changes in attitudes and values. This transformative effect was highly visible in the California cases, where intense dialogue fostered skills in searching for compromise and an openness to others' viewpoints. It reinforced the awareness of the resource as a common good. Conversely, in Taiwan, this learning was almost non-existent due to a culture of hierarchy, the lack of decision-making stakes, and a lack of consistency in participants between workshops.

Result 5

The success of social learning depends heavily on how the participatory process is implemented (procedural aspects). Procedural justice and learning are closely linked: when stakeholders feel well-represented and have equitable access to information, trust in the process fosters learning. The California cases showed that a lack of procedural justice—such as the over-representation of the agricultural sector or a lack of independence from the organizer—can limit learning and lead marginalized actors to withdraw from the process.

Result 6

Social learning is not a neutral process: it depends closely on power dynamics and legitimacy. Power asymmetries negatively affect collective learning, as participants pay more attention to "legitimate" actors. However, these dynamics can shift due to external factors. In Scott and Shasta, state-imposed drought restrictions forced agricultural representatives to consider the environmental coalition's positions, stimulating new learning. In Taiwan, learning remained limited because the academic nature of the exercise did not challenge established power structures or the institutional status quo. Social learning thrives when actors perceive an interest or necessity to reconsider their positions