XINGU Project
Integrating land use planning and water governance in Amazonia:
towards improved freshwater security in the agricultural frontier of Mato Grosso

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THE BELMONT CHALLENGE

To deliver knowledge needed for action to avoid and adapt to detrimental environmental change including extreme hazardous events.

This requires:
- Assessments of risks, impacts and vulnerabilities, through regional and decadal-scale analysis and prediction
- Information on the state of the environment, through advanced observing systems
- Interaction of natural and social sciences
- Enhanced environmental information service providers to users
- Effective international coordination mechanisms

With priority foci being:
- Coastal vulnerability
- **Freshwater Security**
- Ecosystem Services
- Carbon Budgets
- Most vulnerable societies
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What approaches to water resource governance, land management, and information transfer among regions and among water use sectors will improve the sustainability and equity of water resources within socio-environmental systems, and ensure the well-being of ecosystems and humans?
Critical issues for freshwater security of the expansion of agriculture:

(1) *Expansion* of cropland into areas with a shorter rainy season or more variable rainfall *increases vulnerability* of agricultural production to changes in rainfall and climate;

(2) *Intensification* of agricultural practices (such as shifts to double-cropping) extends the period of crop growth to the edges of the rainy season when rainfall is less frequent or more sporadic, also *reduces resilience* of the system by increasing the proportion of renewable water utilized by agriculture;

(3) Changes to land cover and cropping practices caused by agricultural expansion and intensification *alters local patterns of evapotranspiration* (ET) and runoff in ways that can lead to *feedbacks at the regional scale*, decreasing regional rainfall while increasing river flows and potential flooding;

(4) Expansion and intensification of cropping can *degrade water quality* by increasing surface runoff and the concentrations of sediment and nutrients in streams and rivers;

(5) Expansion and intensification of agriculture can *alter aquatic ecosystems* by reducing riparian forest, increasing stream temperatures, restricting fish movements and degrading the quality of stream channel habitats and lowering fish production;

(6) Integration of animal production facilities within more intensive agricultural landscapes can *increase water use requirements* and degrade water quality, especially if animal waste is not carefully managed.
Impacts on environmental and ecosystem services also affect societies in several ways:

(1) Expansion of cropland promotes *changes in social structures* that will impact daily practices such as food intake;
(2) Changes in land use will impact water availability and consequently how people *perceive and use water* in their daily practices;
(3) The shift to new agro-economic practices such as export crop agriculture promotes changes to formal and informal institutions, which will *influence how water is allocated in the region*;
(4) The shift in land use practices also promotes a *changing power dynamics* related to the control and of access to resources such as land and water;
(5) Land use patterns can lead to conflict situations among stakeholders, particularly if *water governance practices* based on negotiation are not in place;
(6) The environment and the importance of the natural resources have different meanings and uses among different stakeholder groups. *The lack of equitable water governance can lead to marginalization*, and undesirable outcomes including reduced water security, particularly among some users, populations or locales.
Landscape analysis

- Land cover/use in past decades
- Development of land changes trajectory matrix

Hydrology

- Balanço hidrico
- Modelagem hidrológica e projeção futura

Water biogeochemistry

- Intensive sampling at coupled micro-basins
- Extensive synoptic sampling over whole upper Xingu

Soil hydrology – resilience to agriculture

Water balance and Virtual Water
Representations and practices of human populations about water as a natural resource

- Identification of local social categories
- Stratified sampling of human populations
- In-depth-interviews about practices and representations related to water as a natural resource
- data analysis and report of results for discussion, interpretation, and implications with participating stakeholders.

Institutional Arrangements

- Understand the power structures behind decision-making processes
- Promote participatory spaces for negotiation

Evaluating Communication Strategies for Policy/Decision Making

Environmental legislation and social representation of human population problems
SYNTHESYS MODEL

Human Dimensions of Environmental Change

External drivers: Climate, globalization

-PRESS: climate change, nutrient loading, sea-level rise, increased human resource consumption
-PLUSES: fire, drought, storms, dust events, pulse nutrient inputs, fertilization

Social template
- Human behavior: Policy, markets, reproduction and migration
- Human outcomes: Quality of life, human health, perception and value

Biophysical template
- Community structure: Species turnover time, trophic structure, microbial diversity
- Ecosystem function: Flux, transport, storage, transformation, stoichiometry, primary productivity

LINKS
- Ecosystem services: Regulating: nutrient filtration, nutrient retention, C sequestration, disease regulation, pest suppression
- Provisioning: food, fiber, and fuel
- Cultural: aesthetics and recreation
- Supporting: primary production, nutrient cycling

H1-H6: Connecting Hypothesis

Collins et al., 2011