Infrastructure is recognized as a driver of economic growth and employment, improving trade connections and accessibility to services. But the development of infrastructure is recognized as a complex task.

- For the environment, infrastructure underpins all the major sources of greenhouse gas emissions: our energy systems, transport systems, buildings, industrial operations and land use.
- For communities, deficient infrastructure planning, reduced access to resources, lack of community benefits, and lack of adequate consultation are recognized as prominent conflict drivers related to infrastructure development.

On a planet stressed by climate change and diminishing natural resources, achieving positive development is an ongoing challenge. Besides, more and more project stakeholders, and civil society in general, are demanding and expecting improved overall development outcomes. Thus, there is a pressing need to integrate sustainability into infrastructure projects.

The concept of sustainable infrastructure considers not only delivering a number of essential services to enable economic development, but it also ensures that projects address the four principles of sustainability, including: social, environmental, institutional, and financial sustainability, over all phases of a project’s life cycle.

To achieve this goal, the way infrastructure is conceived, planned, developed, and operated needs to be transformed.

**Why is sustainable infrastructure important?**

**What are the benefits of sustainable infrastructure?**

The benefits of integrating a sustainable perspective into infrastructure development can result in enhancing directly and indirectly related positive impacts or benefits, including financial and economic benefits.

Key aspects to successfully develop sustainable infrastructure include: Enhancing the quality of life for communities; Helping to preserve limited resources; Protecting the environment; Fostering effective management and cross-sectoral collaboration; Ensuring institutional sustainability over the entire life cycle of the project; Promoting a more efficient use of financial resources.

But these actions are not disconnected. The conception of sustainable infrastructure implies the integration of sustainability principles, generating co-benefits for all stakeholders involved.

On the other hand, taking a sustainable approach to infrastructure entails working across borders, scales, and institutions. Only the integration of local, regional, and national levels, will allow the institutions that support the development of infrastructure to take advantage of the “win-win” features of sustainable infrastructure.

Globally, virtually all countries have committed to multi-sector sustainability objectives through the Sustainable Development Goals (SDGs). Thus, sustainable infrastructure provides a solid foundation to advance in the SDGs vision for inclusive development. Policy makers recognize sustainable infrastructure development globally as key to realizing the SDGs, but stakeholders struggle to prioritize, plan, design, construct, and operate infrastructure that meet the principles of sustainability.
What are the challenges?

1. **Growing complexity of infrastructure**
   Delivering infrastructure is increasingly complex given climate change, environmental concerns, and social challenges. Demographic and market demand changes are transforming the way infrastructure is delivered. Innovative technologies and different business models are necessary to address this complexity.

2. **Multidimensional conflicts**
   The different types of infrastructure and demands to attend, combined various territorial planning scales, levels of governance, and the multiplicity of institutions and stakeholders involved pose an important integration challenge. The failure in addressing these multiple dimensions may end up on project development failure or delays and lack of interest from private sector to get involved.

3. **Excess of data and procedures**
   Given the significant and increase amount of information available on environmental management and sustainability, it is often difficult for specialists to prioritize policies and procedures that should be integrated so that they are far less procedurally burdensome while still being substantively effective.

4. **Limited financial resources**
   Once sustainability aspects are identified, there is the remaining challenge of identifying the correct mechanisms to prioritize the measures that make economic sense to be implemented. The lack of measurement tools to address the financial benefits and positive impacts of sustainable approaches, compromise their ability to be implemented.

5. **Limitations of impacts assessments**
   There are many approaches to adding sustainability value to infrastructure projects, but they are difficult to implement without developing the appropriate technical knowledge and capacities. For stakeholders it remains difficult to identify the right tool to apply and into integrate a broad range od aspects, considering the diversity of infrastructure sectors, phases along the project cycle, as well as geographic locations.

6. **Lack of measuring and monitoring**
   Different frameworks can be used to help agencies refine their visions as well as develop policies and planning procedures for sustainable infrastructure development, but new tools and mechanisms are necessary to enabling measuring and monitoring systems for achieving sustainable outcomes throughout the project lifecycle.

What is missing? How we can transform the way infrastructure is conceived?

**PROBLEM**
A significant proportion of large-scale infrastructure projects bypasses the land use planning system altogether.

**PRESSURES**
The problem will only worsen as metropolitan areas expand due to population pressures, leaving less available land for other functions.

**CONSEQUENCES**
This gap creates future challenges for placing infrastructure, potentially leading to increased opposition to projects, delays and higher construction costs.

**NEED**
Infrastructure planning needs to come with a built-in capacity to handle transversal issues, such as climate change, in a coordinated and integrated manner.

MULTISECTORAL INTEGRATED TERRITORIAL APPROACH FOR SUSTAINABLE INFRASTRUCTURE

Recognize the importance of integrating sustainable criteria with land use conditions, infrastructure planning and long-term planning goals with territorial conditions.
Our Approach

The need to achieve the development of sustainable infrastructure demonstrates that rating systems are an evaluation mechanism, rather than a planning one. Undeniably, the application of these systems allows stakeholders to detect multiple gaps and a diverse range of themes that need to be addressed towards more sustainable outcomes. However, these systems are not able to provide integrated planning solutions that combine the different variables, scales, and actors involved, in order to better inform decision making processes.

We provide a comprehensible sustainable resilient infrastructure approach considering the different phases of the project lifecycle. Our team works at the intersection of urban and environmental planning, public policy, and sustainability practice, to assist clients in unveiling, visualize, and understanding complex spatial dynamics of infrastructure. To do so, we consider geospatial data and analytics to understand the relationships underlying social, economic, and environmental spatial structures across multiple scales and environments. We strive to identify opportunities and synergies for the development of sustainable and resilient infrastructure.

We believe that to address the growing complexity of delivering infrastructure, posed by the multiplicity of needs that projects should address, and to transform the way infrastructure projects are planned, it is necessary to superimpose different topics from the perspective of the territory and to apply innovative technologies and methodologies to the process.

Our geospatial analysis approach ensures an integral and comprehensive perspective applicable from infrastructure conception to project completion.

Example of Analytical Dimension

- Demographics
- Natural Resources
- Infrastructure
- Productivity
- Social Services
- Security

Our services are characterized by a unique set of capacities, which allows us to:

- Integrate public policies and planning guidelines at different scales and institutional frameworks.
- Intersect platforms and data sources in order to provide advice to our clients across administrative boundaries. This also allows us to fill-in data gaps with trustable information from multiple reliable sources.
- Understand and integrate heterogeneous and specific conditions embedded in territories.
- Recognize the diversity and particularities of geographic contexts to propose tailor-made solutions and provide a distinctive approach to enhance sustainability and resilience in infrastructure development.
Selected Experience

TRANSPORTATION AND SOCIAL DEVELOPMENT

Women-led SMEs, Resilient Agriculture and Climate Change Adaptation
Client: The World Bank Group
Country: Bangladesh

The main objective of this project was to carry out a spatially explicit, in-depth socio-economic and productivity assessment in a region that plays an important role in regional trade (e.g. Bangladesh Regional Connectivity Project). This assessment provides a foundation for the capacity building and pilot program proposals for women, especially in agricultural products. By overlaying the value chain analysis with socio-demographic indexes, the study creates a flexible geospatial decision-making tool, that allows stakeholders to create focal areas for capacity building.

Key social sustainability aspects:
• Improve Community Quality of Life
• Enhance Public Health & Safety
• Improve Community Mobility Access
• Provide for Stakeholder Involvement
• Encourage Sustainable Transportation
• Enhance Public Space & Amenities
• Advance Equity & Social Justice
• Promote women empowerment

COMERCIAL INTEGRATION AND LOGISTICS

Territorial economic integration in the Itaipú dam triple frontier
Client: Inter-American Development Bank + Organization of Ibero-American States
Country: Alto Paraná, Paraguay

Alto Paraná is located on the border between Paraguay and Brazil and has been highlighted as the main transportation and economic corridor for trade. However, recent demographic trends in Alto Paraná convey both opportunities and limitations. While the current and potential workforce continues to grow, there is a lack of basic services and infrastructure, which require public and private investments. A territorial diagnosis to identify the productive logics and areas with human capital development opportunities was conducted. Agricultural products to enhance economic growth were selected and infrastructure and social services necessary to leverage its revenues were identified.

Key planning sustainability aspects:
• Foster Cross-border Collaboration
• Pursue Economic Synergies
• Plan for Sustainable Communities
• Stimulate Growth & Development
• Develop Local Skills & Capabilities
• Improve Infrastructure Integration
**WATER MANAGEMENT AND EFFICIENCY**

Exploring Alternatives to Improve Agricultural and Ecological Outcomes on the Bessemer Ditch
Client: David and Lucile Packard Foundation + ICS
Country: Colorado, USA

This project addresses the imminent ecological, and socioeconomic threats precipitated by agricultural-to-municipal water transfers in the Bessemer Ditch irrigated farmlands, in Pueblo, Colorado. This process, called buy-and-dry, has devastating consequences for the landscape, effects that are already visible in neighboring communities, where the land was permanently fallowed, affecting soil, farming activities, and eventually livelihoods. The project developed a series of analyses to prioritize areas of ecological conservation, economic value, and areas where drying-up is likely to have fewer impacts.

**Key environmental sustainability aspects:**
- Preserve Sites of High Ecological Value
- Preserve Prime Farmland
- Manage Stormwater
- Enhance Wetland & Surface Water Functions
- Maintain Floodplain Functions
- Protect Soil Health
- Protect Surface & Groundwater Quality
- Enhance Functional Habitats

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**CLIMATE CHANGE AND RESILIENCY**

Climate change and public spaces: Adaptation strategies to climate change using public spaces
Client: Ministry of Environment and Sustainable Development
Country: Colombia

Green infrastructure has the potential of promoting multiple functions for communities. Public spaces create stronger communities, improve life quality, and generate economic benefits. Also, these areas are an essential part of larger ecosystems. Departing from the multifunctional role of green infrastructure, this project focuses in the study of public spaces in three cities in Colombia: Barranquilla, Bucaramanga, and Cali. The objective of this work is to formulate strategies to strengthen the network of public spaces as an instrument to confront climate change and enhance resilience.

**Key climate change sustainability aspects:**
- Reduce greenhouse gas and air pollutants emissions
- Avoid unsustainable development (risk areas)
- Reduce climate change vulnerabilities
- Enhance social and environmental resiliency
- Improve infrastructure integration
- Manage storm water and maintain floodplain functions
- Enhance functional habitats
Our main aim is to collaborate with stakeholders to integrate standards of sustainable design and help them to promote better environmental and social management in the region’s infrastructure projects. To do so, the services provided by GeoAdaptive are tailored to the needs of a variety of stakeholders involved in the development of infrastructure; ranging from local governments to regional and national institutions, non-profit organizations and communities, to multilateral organizations.

Our clients are interested in improving resource efficiency and productivity, maximizing the array of co-benefits while minimizing the adverse impacts associated with infrastructure development, such as managing environmental, biodiversity and water resources associated with new projects, as well as engaging with affected communities. In doing this, we generate complex economic base analyses and spatially-explicit strategies to target appropriate policies and planning efforts for robust and resilient infrastructure systems in the context of climate change, population growth and urban expansion.

A systemic territorial integrated approach to sustainable infrastructure, allows consistency between public policies, regulatory frameworks, institutional organizations, infrastructure and support services.

As result, we can contribute to enable business development, increasing investment and improving competitiveness, by minimizing uncertainties and conflicts related to infrastructure. Also we can help to advance in achieving the SDGs vision by promoting equitable growth and preserving the environment for future generations.

Our Motivation

1. Provide cross-sectoral solutions and policy recommendations
2. Formulate planning-focused tools to improve project definition and preparation
3. Contribute to build a better understanding of sustainable infrastructure
4. Address main gaps in information to formulate integrated planning strategies

Opportunities

- Promote inclusive growth and productivity
- Enhance coverage and quality of services embodied in the SDGs
- Accelerate the transition to low carbon
- Foster growth and climate resilient economies
- Enhance collaboration and integrated project management
- Facilitate project development and financing
- Detect enabling conditions for sustainable development

Sustainability Principles

- Economic
- Financial
- Environmental
- Social
- Institutional

Integrated Project Design

- Detect opportunities and challenges
- Measure multiple impacts
- Enhance multilevel coordination
- Formulate multisectoral projects
- Anticipate conflicts

Framework for a Sustainable and Resilient Planning and Monitoring in Infrastructure
Products and Services

Climate change adaptation and mitigation
- Vision and planning for medium and long term
- Retrospective impact studies and mitigation strategies

Quantify and measuring performance
- Quantification of impacts and cost-benefit CO2 emissions
- Life cycle analysis (net embodied energy) in the supply chain

Integration and coordination
- Public policy recommendations and governance frameworks
- Identification of institutional coordination actions

Multisectoral project portfolio
- Identification and prioritization of multisectoral project portfolio
- Multi-sectoral coordination schemes (Distribution of responsibilities)
- Cost - benefit evaluations for investments

Sustainable systems
- Design guidelines for infrastructure sustainable development
- Identification of indicators and monitoring of performance
- Site analysis and feasibility analysis

Inclusive economic development
- Socio-economic evaluation for risk mitigation in critical infrastructure
- Multi-hazard risk analysis and prospective development scenarios
- National economic strategies for inclusive development

Main areas of our work

National, regional, and international connectivity
Mobility and accessibility analysis for transportation networks; Multimodal centers and logistics platforms; Logistics network including airports, trains, ports

Territorial planning strategies; Urban development; Coastline resilience

Urban, regional, and national planning strategies; Coastal planning and resilience strategies for climate change; Land use analysis and public policies recommendations

Quality of life indicators; Public spaces networks; Green infrastructure and urban water management; Socio economic analysis; Human capital analysis

Green infrastructure and public spaces; Equity and life quality; Human capital

Water management, hydrological systems, and irrigation infrastructure
Plans and public policies of agricultural irrigation; Reservoir systems and aquifer analysis; Drinking water systems

Carbon footprint analysis; Life cycle approach; Cross-border integration

Measurement of CO2 emissions and reduction strategies; Traceability of materials; Identify by-products synergies; Cross-border and cross-sectoral regulations and policy framework analysis
Our Firm

GeoAdaptive is a global sustainability research consultancy group based in Boston, Massachusetts. We use spatial technology to understand these challenges and the inherent spatial relationships between vital components of the natural and urban landscape, as well as to highlight future opportunities for adaptation and increasing resilience.

We work closely with partners, clients and communities helping them explore the risks and opportunities associated with future regional change in urban development patterns, climate change, and natural hazards. We do this in a number of ways including defining appropriate best management strategies for the region, highlighting areas of the region or city where these strategies might be implemented (through geospatial analyses), and recommending changes in policy or planning.

GeoAdaptive’s spatial and statistical analysis provides an analytical insights for the purpose of designing infrastructure that incorporates the key element of “where”.

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