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Abstract

This milestone report summarizes the work undertaken in the first year of WP1 to support the process of identification and definition of global challenges and mitigation and adaptation policies on focus in the Global-IQ project, and to coordinate in particular the definition of common assumptions for Shared Socio-economic Pathways (SSPs) as starting point to develop comparable qualitative and quantitative future Global-IQ scenarios and modeling applications.

The common learning process and the support provided to the restricted group of Global-IQ partners by a dedicated wiki tool is described. The wiki tool can be accessed at http://www.isis-it.com/wiki/

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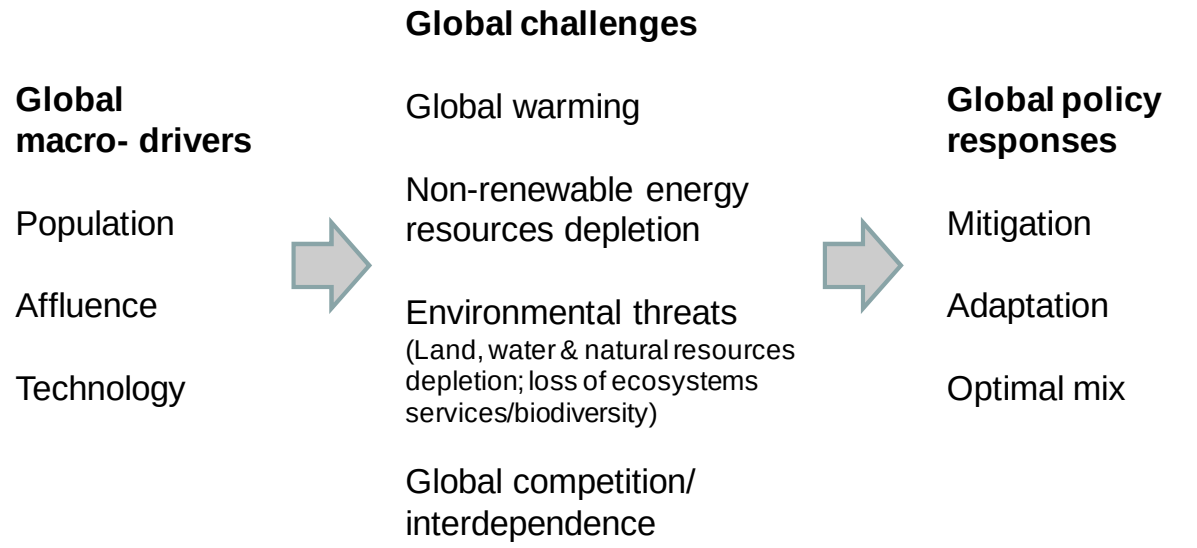
1. Understanding Global Changes

In today's world, human impacts on ecological life support systems are increasingly complex and far-reaching. In this world, the emphasis needs to shift from addressing problems in isolation to studying whole, complex, interconnected systems and the dynamic interactions between their components. Analysing global changes and impacts is indeed a complex issue, which cannot be addressed only within the confines of any single discipline.

This is the reason why Global-IQ *WP1 Understanding Global Changes* starts with an interdisciplinary and system overview of the complex, dynamic history and future of human-environment interactions at the global scale. We are going to live in a world increasingly crowded (the average UN population projections forecast a total population of 9 billion in 2050, mostly growing in the developing countries), flat (as the standard of living will tend to increase in the developing countries, and globalised lifestyles to spread over the world), and hot (as global warming will continue, pushed by growing anthropogenic pressures).

In this context, the focus of the GLOBAL-IQ project will be to consider global macro-drivers, global challenges and possible global policy responses, as depicted in the figure below:



In the context of the overall project, WP1 will aim to initiate, support and evaluate a *common learning process*, involving the partners in charge of quantifying global impacts in the other WPs. This common process will aim to share assumptions and future outlooks related to four global challenges:

- Global warming.
- Global non-renewable energy resource depletion.
- Global environmental threats (land, water and natural resources depletion; loss of ecosystems services/biodiversity).
- Global competition/interdependence.

2. The Global-IQ wiki tool

A Global-IQ wiki platform has been implemented to help the partners to develop step by step:

- the design of the **Global IQ conceptual framework**, providing a detailed description of the global IQ focus, definitions of mitigation and adaptation challenges and overarching goals;

- the development and fine tuning of **shared assumptions** related to different future socio-economic pathways (SSPs). The latter are based on the existing explorative scenarios currently being developed in the scientific community of Integrated Assessment Models (IAMs) builders world-wide. Based on a first set of shared assumptions concerning population, technology, land use change, etc., Global-IQ may develop two options: a) a scenario-based approach, where we take the existing storylines of the SSPs and extend them to cover the global challenges focused upon in our project; b) a sensitivity study-type approach, where we take one "middle range" socio-economic pathway as a reference (actually SSP2), and identify a few indicators for each global challenge and vary those individually and in combination, measuring likely future impacts in comparison to the baseline case. The identification of shared assumptions is being done in connection with the WP3 enhancing, harmonization and soft linkage of global models;

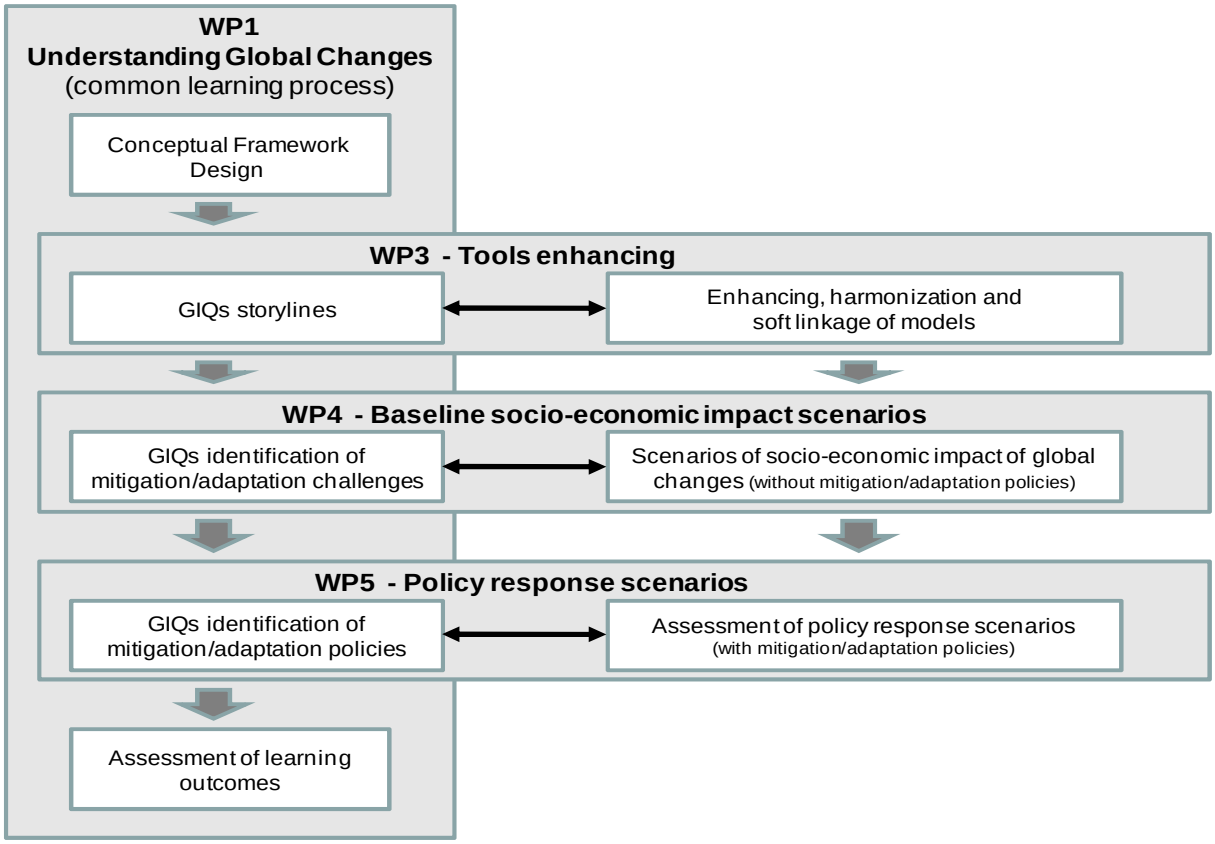
- the identification and qualitative description of the **mitigation and/or adaptation challenges** related the four global challenges. The description may take the form of Global-IQ storylines based on the SSPs narratives expanded and deepened to take more into account the global warming, non-renewable resources depletion, environmental threats and global competition problems, or alternatively of sensitivity analysis case studies. This is to be done in connection with the WP4 production of quantitative scenarios of socio-economic impact of the global challenges (i.e. "do-nothing" scenarios without specific mitigation/adaptation policies put in place);

- the identification of specific **mixes of mitigation and/or adaptation policies** to respond to the global challenges in the different possible future scenarios. This is to be done in connection with the WP5 production of quantitative policy response scenarios;

- the final evaluation of the common learning process.

The overall WP1 common learning process that will be managed through the wiki tool, and its relationship with the other core WPs of the project, is summarized in the figure below:

GLOBAL-IQ FRAMEWORK – Process Overview



As the aim of the WIKI tool is to facilitate a common understanding and research co-production between the Global-IQ partners, for the time being we are doing a private use of this platform, which can be accessed at http://www.isis-it.com/wiki/ .

The following sections summarise the current content of the platform, accessed on 3 August 2012. The wiki text will be continuously updated and adapted to the subsequent research steps.

3. The Global-IQ conceptual framework

The global impacts of humans on the environment can be analyzed in terms of three components or "macro-drivers": the scale of economic activities, the composition of these activities in terms of whether they involve goods or services, and the technologies employed. Scale, composition and technology are the proximate determinants in an economy of what resources are required, what wastes will be generated, and how much land will be transformed.

One way to investigate the relationships among scale, composition and technology in the global economy - the main focus of Global-IQ - is to start with a simplified framework, the "IPAT" equation (Ehrlich and Holdren, 1971):

$I = P \times A \times T$ where I=impact; P = population; A = affluence (GDP/population); T = technology (impact/GDP)

In the equation, ''I'' can be any kind of environmental impact on sources, sinks and services measured as a flow, for example tonnes of carbon dioxide per year. ''P'' and ''A'' are both scale factors. Other things equal more of each means more environmental impact. Multiplying ''P'' and ''A'' gives Gross Domestic Product (GDP), the aggregate output of the economy. ''T'', measured as impact per unit of GDP, is where technology comes in. In this context, technology means the extension of human capacity to interact with nature: to use more or less materials and energy, to create more or less of different kinds of wastes, and to transform land in various ways and to varying extents. Technology encompasses what we produce and how, the kinds of goods and services that we consume and the transportation and information methods used in distribution. Usually the same technology operated at a larger scale will increase impact. but we can have economic growth without increasing impact if we also get a sufficient reduction in impact per unit of GDP from new and improved technologies.

A variant of the IPAT equation is the Kaya identity (Kaya 1989; IPCC, 2000), which describes future emission levels (impacts) as a simple multiplicative function of population, income per capita, energy per unit of income (energy intensity) and emissions per unity of primary energy (carbon factor). More recently, the carbon capture technology is also considered in further variants, adding a terms for carbon storage per unit of emissions.

One of the criticism of the IPAT equation and its variants, is that they are too simple. To correctly disentangle the interaction between global drivers and global impacts we need to integrate different models into a coherent Integrated Assessment Models (IAM) framework. This is done in Global-IQ by linking into an harmonized application framework different models which address population and economic growth in different regions of the world, modeling global competition challenges, the energy system, modeling global energy challenges, the land use and biosphere system, modeling global environmental threats, and the climate system, modeling global warming impacts.

A state of the art description of the global challenges – global competition/interdependence, depletion of non-renewable energy, global environmental threats, and climate change impacts – is provided, based on excerpts from the recent ESPAS (European Strategy and Policy Analysis System) pilot report ''Global Trends 2030: Citizens in an Interconnected and Polycentric World'', edited by Alvaro de Vasconcelos (EUISS, 2012). The EUISS report provides an initial assessment of the long-term international and domestic political and economic environment facing the EU over the next 20 years.

The analysis of global change is at the heart of the GLOBAL-IQ project. As illustrated in the relevant WIKI section, global change encompasses climate change, but we do not exclusively limit ourselves to climate change impacts. On the contrary, the analysis will also cover changes in demography, technological breakthroughs, shifts on the demand side (e.g. in diets), etc. In order to be able to cover all relevant sectors, we have chosen to include a wide array of models into an harmonized set. Table 1 provides an overview of the sectors and models.

	Agriculture & forestry	Water, energy, fuels availability, energy security	Transport, infrastructures, tourism	EU competitiveness, labor market, international trade, financial stability	Population, health, migration
GLOBIOM	X	X			
WITCH		X	X		
MagPIE	X	X			
REMIND		X	X	X	
ICE				X	X
ICES			X		

Table 1: Model distribution across sectors

The single models are described in more detail in WIKI sub-sections. Note that the interrelations displayed in Table 1 are not meant to be exhaustive: for instance, changes in infrastructure will have impacts on agriculture as well and models can be adapted to replicate global changes, which are not modeled in them explicitly yet. GLOBIOM and WITCH, for example, will establish an inter-model link, via which it will be possible in WP4 to assess how impacts that affect agricultural sector productivity will change macroeconomic investments and long-term growth, especially in developing countries, where agriculture accounts for a large part of GDP.

This example already points to one channel of harmonization in this project: the linking of models in order to produce consistent estimates of impacts and to capture as many interaction effects (trade-offs and synergies) as possible. It is important to note that the Global-IQ Description of Work also explicitly calls for an alignment of models' assumptions on exogenous trends, but posits that models-specific structures will be preserved, "without attempting to conduct a thorough and coherent modeling comparison exercise." The goal is instead to maximize the exchange of information among models – e.g. by means of soft-links – in order to design richer scenarios and produce more accurate impact estimates and adaptation options in WP4 and WP5, with the ultimate goal to identify the optimal trade-off between mitigation and adaptation to major impacts of global changes.

4. The Global-IQ Scenario Framework

An initial decision has been taken in Global-IQ to analyze global changes and impacts using a scenario framework recently defined for a new generation of socioeconomic scenarios for climate change impact, adaptation, vulnerability and mitigation research (illustrated in N. Arnell, T. Kram, 2011, mimeo).

The rationale behind this choice is to connect the Global-IQ research to the mainstream research and efforts that the Integrated Assessment Modeling (IAM) community, the Impacts, Adaptation and Vulnerability (IAV) community and the Climate Modeling (CM) community are currently doing to eventually produce comparable global change and impact scenarios. Such effort to produce integrated global scenarios is known as the so called '''Shared Socio-economic Pathways''' approach (SSPs, sometime stated as Shared Socio-ecosystems Pathways). This is currently developed in the scientific community and is part of a larger endeavour originated by a request of the Intergovernmental Panel on Climate Change (IPCC) to develop a new set of scenarios to facilitate future assessment of climate change (IPCC, 2007).

The Global-IQ project will adopt the SSPs framework as starting point to develop its own work, focusing on mitigation and adaptation challenges related to the global challenges on focus. This implicitly recognises that the different global challenges can be organised as sub-systems that are concatenated following the IPAT identity logic as illustrated in the figure below:

OVERVIEW OF THE GLOBAL IQ SYSTEM

	GLOBAL COMPETITION CHALLENGES	**GLOBAL ENERGY CHALLENGES**	**GLOBAL ENVIRONMENTAL CHALLENGES**	**GLOBAL WARMING CHALLENGES**
GLOBAL COMPETITION CHALLENGES	*- Shared Socioeconomic Pathpawys (SSPs) about population, growth, technology and market governance* *- Shared global competition policy assumptions (SPAs)*	Effects on global energy challenges	Effects on global environmental challenges	Effects on climate change
GLOBAL ENERGY CHALLENGES	Feedbacks of global energy to global competition challenges	*- Shared Socioeconomic Pathpawys (SSPs) about energy consumption, supply mix, technologies and markets* *- Shared global energy policy assumptions (SPAs)*	Effects on global environmental challenges	Effects on climate change
GLOBAL ENVIRONMENTAL CHALLENGES	Feedbacks of global environmental to global competition challenges	Feedbacks of global environmental to global energy challenges	*- Shared Socioeconomic Pathpawys (SSPs) about land use change, land productivity, ecological factors* *- Shared global environmental policy assumptions (SPAs)*	Effects on climate change
GLOBAL WARMING CHALLENGES	Feedbacks of global warming to global competition challenges	Feedbacks of global warming to global energy challenges	Feedbacks of global warming to global environmental challenges	*- Shared socioeconomic Pathpawys (SSPs) about global mitigation and adaptation challenges* *- Shared global climate policy assumptions (SPAs)*

= Shared assumptions

= Interaction effects

Global climate change is the last and overarching global impact in the chain. Indeed, climate change is usually projected to impact human and natural systems, with differential consequences across regions, sectors, and time. The magnitude and extent of future impacts will depend on the response of the Earth system to atmospheric composition; the effectiveness of mitigation and adaptation options to avoid, prepare for, and respond to impacts; and on development pathways, including changes in demographics, economies, technologies, and policies. Scenarios can be used to explore and evaluate the extensive uncertainties in each of these. The term ''scenario'' describes a comprehensive description of the future of the human climate system, including quantitative and qualitative information. This can be distinguished from the term ''pathway'' that describes scenario components such as atmospheric concentration or development indicators.

A roadmap for the generation of new scenarios was laid out in Moss et al. (2008) and summarized in Moss et al. (2010). The new scenarios will provide quantitative and qualitative narrative descriptions of socioeconomic reference conditions that underlie challenges to mitigation and adaptation, and combine those with projections of future emissions and climate change, and with mitigation and adaptation policies. Global-IQ will aim therefore to contribute to this process, which engages the CM, IAM, and IAV communities in the preparatory, parallel, and integration phases, by producing its own set of consistent and comparable Global-IQ scenarios.

An extensive description of the SSP scenario framework is provided in the wiki, based on the draft scenario framework paper (N. Arnell, T. Kram, still unpublished). This provides guidance to help Global-IQ partners to identify shared assumptions to implement SSPs in Global-IQ.

The description includes at the moment shared assumptions identified by the concerned research teams for the GLOBIOM modeling framework, and for the coupled ReMIND and MAgPIE framework

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