Earth Observations, Models and Geo-Design in Support of SDG Implementation and Monitoring

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THE COMPLEX SYSTEM CHALLENGE

In October 2015, the United Nations' Plenary agreed on the Agenda 2030, the "Road to Dignity," as the Secretary General of the United Nations denotes it, which aims to achieve seventeen ambitious Sustainable Development Goals (SDGs) by 2030. The SDGs cover almost all areas of human activities and their impact on the Earth's life-support system (Table 1). Each of the broad goals has a set of associated tangible targets. Each target comes with a set of target-specific indicators to measure the progress towards the targets. Making progress towards these targets will require the development of policies and the implementation of specific actions that can facilitate this progress. It is a foregone conclusion that due to the broad nature of the goals and the global intergovernmental involvement achieving each individual goal presents a complex system challenge. All goals pose highly complex, wicked problems to society. Implementation and Monitoring of the SDGs requires support from Earth observation and scientific communities.

Table 1: The Seventeen Sustainable Development Goals

	Goals	Description of Goals
1	No Poverty	End Poverty in all forms everywhere
2	Zero Hunger	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3	Good Health and Well-being	Ensure healthy lives and promote well-being for all at all ages
4	Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5	Gender Equality	Achieve gender and empowerment for all women and girls
6	Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all.
7	Affordable and clean energy	Ensure access to affordable, reliable, sustainable and modern energy for all.
8	Decent Work and Economic growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9	Industry, Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10	Reduced Inequalities	Reduce inequality within and among countries
11	Sustainable Cities and Communities	Make cities and human settlements inclusive, safe, resilient and sustainable.
12	Responsible Consumption and Production	Ensure sustainable consumption and production patterns.
13	Climate Action	Take urgent action to combat climate change and its impacts
14	Life Below water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15	Life on Land	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land.
16	Peace Justice and Strong Institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive.
17	Partnership for Goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development.

GEO-DESIGN FOR DATA AND MODEL INTEGRATION

Geo-design operates in the realm of infrastructure and the built environment (Fig. 1) It facilitates informed development in advance of perceived needs, thus leading to sustainable construction development. The interoperability of technology facilitates integration of the subsystems of research and construction from the macro to the micro level, essentially developing conflict resolution mechanisms. It has the potential to bridge the gap between science; social needs; economics; and policy helping to resolve issues involved in designing the built environment. Integrating technologies offers a dynamic way of representing unseen patterns and contextual relationships across global, regional and local areas.

REFERENCES

Jules-Plag, S. and Plag, H.-P., 2016. Supporting Agenda 2030's Sustainable Development Golas - Agend-Based Models and GeoDesign. ApoGeoSpatial, 31(4), 24-30, Fall 2016.

The work was partly funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 641538.

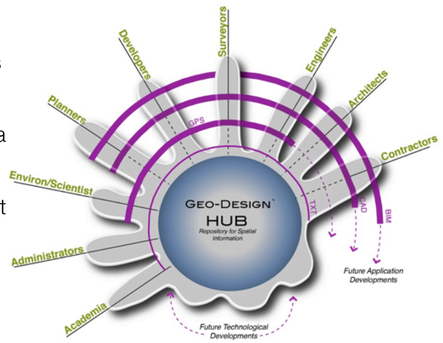

Figure 1: A Geo-Design Hub combines components of simulation tools for the assessment of policy impacts.

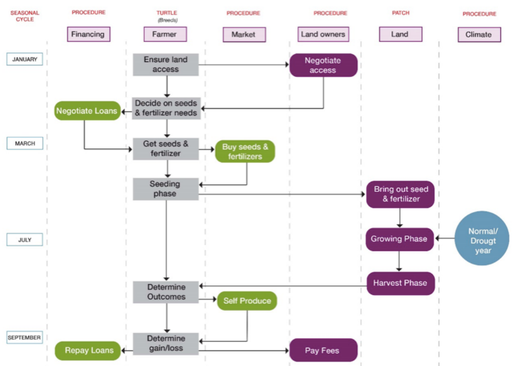

Figure 2: Flowchart showing the agents and procedures in the subsistence farming ABM.

AGENT-BASED MODELS IN SUPPORT OF POLICY DEVELOPMENT

Equation-based models have very limited value for problems as complex (and wicked) as reaching the targets and SDGs. The advantage of agent-based models (ABMs) is in the ability to provide an environment for us to experiment and explore when we are not totally clear on all of the issues impacting a problem. As an initial step, one of us (Jules-Plag) has developed an ABM for subsistence farming (Fig. 2). The aim of the ABM experiment is to determine the factors that impact gender equality through land ownership and access to financing in support of subsistence. Policy options in the ABM to increase equality are those that impact land ownership and access to financing. The initial exploratory system model simulates the seasonal cycle of buying seeds (including getting financing, if needed), seeding, growing, harvesting, and utilizing (marginal) gains. The agents are the male and female farmers; land-owner societies; markets to buy seeds and fertilizers and sell produce; traditional financial sources (banks) and micro-financing actors. This model was run over the seasonal cycle for a period of 100 years for many different scenarios. The information obtained from the analysis provides valuable guidance to the policy conditions that have the potential to improve the success of subsistence farming by female farmers and reduce gender inequality. Decoupling land ownership from financing and introducing quota systems are two potential policy options that may be considered based on the results.

INTERACTION OF SDGS

We use the example of SDG 5 (Gender equality, Fig. 3) and SDG 11 (Sustainable Cities and Communities, Fig. 4) to underline the cross-goal linkages and the joint benefits of Earth observations, data integration, and modeling tools for multiple SDGs. The forms of gender inequality differ across cultural regions, and the spectrum of economic and social barriers for progress towards the goal has considerable spatial variability. It would be impossible to take a comprehensive look at the scope of this goal, so here one branch of policy support is considered. The targets of Goal 11 focus on access to housing, transportation and green spaces; the promotion of planning and the enhancement of architecture and technology to reduce pollution and improve resilience to climate change, thus minimizing the loss of human life and resources (paying special attention to the protection of natural heritage centers). Similar to the case of Goal 5, many of the other goals have targets that are relevant to the targets of Goal 11, but the indicators for these targets mostly are not focused on the scope of Goal 11. A particular challenge for the targets of Goal 11 is in the development of indicators for such wide targets. We consider two of the targets relevant to the development of sustainable human settlements:

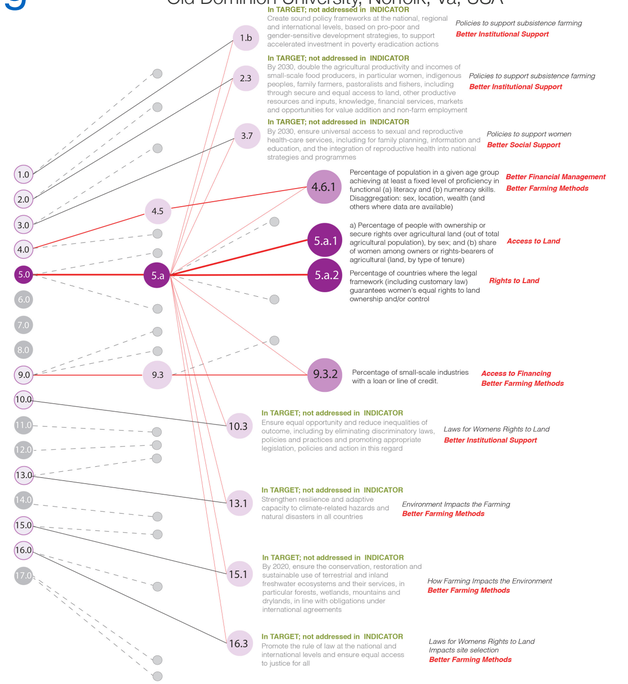

Figure 1: Relevance of Different SDGs and Targets for Gender Equality in Subsistence Farming

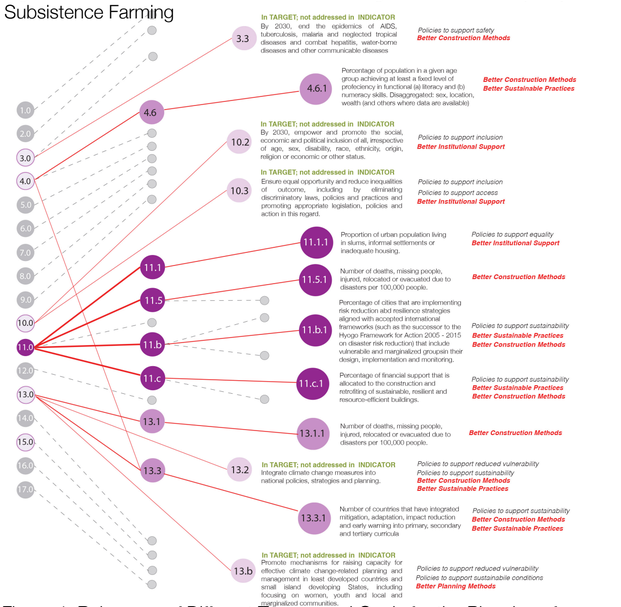

Figure 4. Relevance of Different Targets and Goals for the Planning of Sustainable Human Settlements.