The Wisdom of G.O.A.T.S.

(Global Overview Assessment of Technological Systems)

Technology Landscaping and Participatory Technology Assessment:
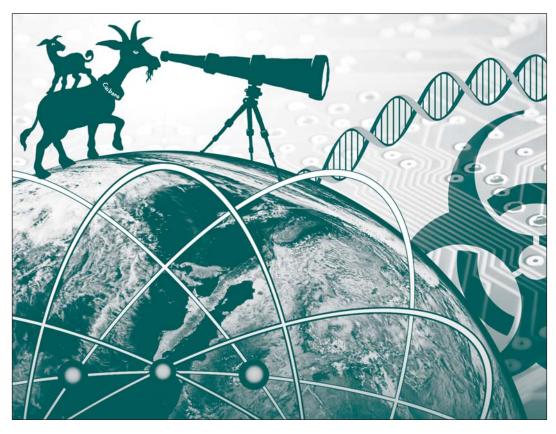### A Proposed Approach to Science, Technology & Innovation (STI) Governance for Sustainability

Policymakers are placing a lot of trust these days in the idea that technology can deliver a better world. Technology is established as a key cross-cutting theme of the 2030 Agenda for Sustainable Development which charts a path to the future for governments, and 13 of the 17 Sustainable Development Goals (SDGs) specify that technological solutions will be necessary to achieve them.

Meanwhile, for better or worse, disruptive and powerful technological platforms are now transforming our societies and environment at speed – from artificial intelligence (AI) and robotics to biotechnology and blockchains. To be sure-footed in navigating this rapidly-shifting technological terrain and to not butt up against false solutions, governments and other policymakers need better maps and decision-making tools to make wise choices about technology.

To help improve innovation governance, ETC Group is proposing GOATS– Global Overview Assessment of Technological Systems. GOATS offers an exploratory approach for policymakers, civil society and others to better perceive and navigate the rocky innovation landscape ahead, and to understand the potential promises and pitfalls in advance.

GOATS is proposed as a bottom-up 'technology landscaping' project involving multi-actor assessment, organised thematically around the 17 SDGs. Through solicitation and engagement with society, the GOATS project will first build a field view of key technologies, innovations and technological visions that are shaping the different themes under discussion in the UN's High Level Political Forum (HLPF). It will then attempt to anticipate and evaluate the potential societal implications of key technological developments. GOATS could serve as an essential input to the deliberations of the UN Technology Facilitation Mechanism and the HLPF, as well as to the the UN's Global Sustainable Development Report.

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Overview Assessments for Sustainable Development Policy – a well-trodden path

In complex policy areas, Global Overview Assessments are becoming commonplace inputs to multilateral decision-making – particularly on topics relating to sustainable development. Global Overview Assessments differ from review studies by bringing multiple actors into the assessment. They range from expert- and government-led assessments to more consultative multi-stakeholder processes, with varied links to formal governance processes.

Examples include:

Climate: Since 1990, international negotiations on climate change through the UNFCCC have been grounded in a series of five overview 'Assessment Reports' produced by the International Panel on Climate Change (IPCC) – an expert-led process that identifies relevant knowledge for formal consideration by governments. The IPCC Assessment Reports are produced in a four-year cycle (they are currently working on AR6).

Food And Agriculture: The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) was a three-year multi-stakeholder collaborative process engaging 900 participants and 110 countries, with co-sponsorship of the FAO, Global Environment Facility, UNDP, UNEP, UNESCO, the World Bank and WHO. IAASTD carried out both a global assessment and five regional sub-assessments of the state of science, technology and innovation related to agriculture between 2003 and 2007.

Environment and Biodiversity: Since 1995, the Parties to the UN Convention on Biological Diversity have requested the preparation of the Global Biodiversity Outlook – now on its fifth cycle. This is an overview assessment of the status of biological diversity and the steps being taken to ensure that biodiversity is conserved, used and shared sustainably and equitably. Also notable has been the Millennium Ecosystem Assessment (MEA), a scientific appraisal – at multiple scales – of the condition and trends in the world's ecosystems and the services they provide. The MEA was overseen by a board comprising United Nations entities, civil society and the private sector.

Technology Landscapes, Maps and Participatory Technology Assessment

The term 'Technology Landscape' refers to structured overviews of the technologies applicable to a particular area of interest. For example, in intellectual property studies a technology landscape study might map a set of related technological approaches to understand the trends of how technologies are being developed and who owns them. However, the same approach of mapping technological developments can also be used for technology foresight exercises, where governments and industries study trends in innovation to better place investments and to craft regulations and policies.

Mapping a field view of technological developments is one thing, evaluating those technologies for their promise and perils is a different domain known as Technology Assessment.

"Assessments generally allow us to tackle broad and complex issues and support the discovery of solutions to address identified problems and challenges."

– UN DESA, Prototype Global Sustainable Development Report 2014.

Formal academic and government-led Technology Assessment is a mature professional field with several governments and their parliaments, particularly in Europe, maintaining dedicated Technology Assessment Offices. While expert-led technology assessment methodologies are common, the biases and blind spots of technocratic experts can prevent a wider range of knowledges and experiences from being brought to the task of technology evaluation for societal impacts. In response, Technology Assessment Offices, as well as citizen movements and social scientists have pioneered participatory methods of technology assessment that seek out and include citizens' views, values and experiences.

This includes prioritizing the knowledge of women, children, marginalized groups, workers, indigenous peoples and others when assessing new technologies. Participatory Technology Assessment (PTA) may include a range of techniques from citizens' juries, tribunals and inquiries to scenario building, prediction markets and 'serious games.'

A Sure-footed G.O.A.T.S. Methodology:

Survey, Situate, Sample, Assess, Suggest

In this proposal, ETC Group suggests a process that would combine experience from multi-actor Global Overview Assessments with the methodology of technology landscaping and the principles and practices of Participatory Technology Assessment. The aim is to design a light but inclusive process, grounded in participation, that welcomes diverse experiences, values and perspectives as inputs. The overarching goal is to synthesise and generate useful knowledge for policymakers and society to govern science, technology and innovation. We envisage a GOATS process overseen by either a multi-actor governance group or by an explicitly citizen-led secretariat committed to ensuring that participatory methods are employed and that diverse voices are heard.

The GOATS process would proceed in five stages: Survey, Situate, Sample, Assess, Suggest. These are described in more detail below.

Stage 1: Survey
– Mapping and Clustering Technologies

In this initial stage, the GOATS secretariat or oversight group would first identify a thematic focus for the upcoming GOATS report that reflects the themes under discussion in the High Level Political Forum and the STI Forum - namely the specific SDGs under consideration (e.g. technologies affecting food security, nutrition and agriculture, energy technologies, marine technologies or technologies for sustainable production and consumption). The secretariat would then issue a call for partners, including major groups such as civil society organizations and movements, to identify technologies relevant to the theme under discussion. This call may be issued through several channels including regional technology assessment platforms, in partnership with key civil society and professional networks and through regional to national technology assessment offices. The call would ask partners to identify technologies relevant to the chosen theme. The call could encompass existing technologies as well as emerging and speculative technologies, but the process should have a special focus on identifying technologies that are new and under development.

An initial group of authors (appointed by the GOATS secretariat) can then sort through the submitted lists and descriptions of relevant technologies, determining the maturity of the technologies considered (are they in use? at proof of concept? under development? or highly speculative or infeasible?). The technologies can then be clustered according to technology platforms and broader 'families' of approach (e.g. clustering technologies relevant to data and information processing, clustering molecular-level technologies, clustering large scale eco-system scale technologies). In an initial report, technologies should be briefly described and key applications highlighted. Clusters of relevant technologies and the crossovers between them can be presented graphically as well as in narrative form, accompanied by a determination of relative maturity.

Stage 2: Situate
– Mapping Innovation Agendas

Its not as if new technologies arrive from nowhere. The process of innovation is often driven consciously or unconsciously by larger innovation agendas and visions, including cultural and industrial projects, and is shaped by the investment organised around those agendas. For example, the European Union is pursuing deliberate innovation agendas around the vision of the bioeconomy, the 'circular economy' (recycling waste and resources) and notions of 'advanced manufacturing.' Marine technologies may be shaped by the agenda of a 'blue economy' or creating 'sea-steads' as autonomous governance zones, and developments in energy technologies may be driven by agendas of 'renewable energy,' 'decarbonisation' or 'energy independence.' Understanding these sometimes-conflicting visions and agendas helps contextualize the technologies described in stage 1 in real world dynamics.

By mapping the innovation agendas that are bearing down on a thematic area, it is possible to understand which applications may be more likely to arise towards which outcomes, and with what resources and economic and political support. By understanding who drives innovation agendas and which technologies they prioritise, it is possible to ask not only 'which innovation' is underway in a given technology landscape, but also to ask, 'by whom?' 'for whom?' and 'who is excluded?'

Stage 3: Sample
– Case Studies

Having established a field vision of the technological landscape around a theme, it may be possible to then identify specific technology developments that appear to raise broader issues for evaluation. The next step in a GOATS process therefore would be to choose meaningful case studies and develop a fuller picture of those technologies.

Among the criteria for choosing a set of useful case studies as samples would be to choose a mix of both nearer-term and longer-term technologies, and to identify technologies that appear to have considerable political or financial support. In an era when convergence of technologies and synergies between technology platforms is regarded as driving high tech innovation, cross-domain technologies might warrant close attention, as well as technologies that are relevant for several different innovation agendas. Each sampled technology would be further studied, to more fully describe the state of that technology, including the state of research, development and investment, and the suite of applications that are moving forward. The case study phase should pay close attention to claims and hype, technical limitations, existing controversies and any ethical risk and social concern that may have already been raised and/or assessed. Where possible, data about key developers and holders of intellectual property (whether public or private) should be provided. Case studies can be synthesized as short (2-4 page) overview resources.

Stage 4: Assess
– Participatory Technology Assessment

The next stage of GOATS, assessment, is envisaged as the most participative, drawing on the material already developed through the process. Participatory technology assessment exercises could be narrowly framed around the case studies, or processes could be designed to draw out overarching assessments across the technology landscape (e.g. comparing different technologies against the goals and targets of the SDGs.

Examples of participatory assessment methods that could be applied at this stage include:

- Multicriteria Mapping (where citizens and movements first articulate and prioritise values against which they wish to rate a technology innovation)
- Technology citizens' juries,
- Red-teaming (a debate approach),
- and Creative scenario-building methods.

Civil Society groups are currently experimenting with regional networks for participatory technology assessment, called Technology Assessment Platforms (TAPs). For example, Red TECLA (see www.redTECLA.org) is the civil society platform for assessing emerging technologies in Latin America.

Stage 5: Suggest
– Recommendations for Science, Technology and Innovation Governance

Evidence suggests that effective global assessment processes are those with more formal ties to policy processes (e.g. IPCC Assessment Reports which formally input to the UNFCCC negotiating process). While GOATS would be designed to thematically mirror the priorities established by the HLPF and STI Forum under the 2030 Agenda for Sustainable Development, the results of the GOATS process would also be relevant knowledge to inform other multilateral, regional and national policy processes (e.g. on food, energy or marine protection). While framing conclusions across a landscape assessment may be challenging, a secretariat or key authors could be tasked with developing conclusions for policy by way of targeted recommendations for specific fora and processes. Such recommendations could span from process questions (e.g. options for embedding technology landscaping and assessment into existing governance processes), to content- and technology-specific recommendations for further action or inquiry.

Agri-Food GOATS - An illustrative example

At this stage, the concept of a Global Overview Assessment of Technological Systems (GOATS) is still just a proposal.

The following diagram illustrates how the 5 part GOATS process (Survey, Situate, Sample, Assess, Suggest) might be applied in the context of evaluating the Science Technology and Innovation relevant to SDG 2, which aims to "End hunger, achieve food security and improved nutrition, and promote sustainable agriculture."

Stage 1: Survey

Initial Call: What are the technologies and Innovations that are relevant to Hunger, Food Security, Nutrition and Agriculture?

Distributed via: Governments, Technology Assessment Platforms (e.g. Red TECLA), UN Major groups (e.g. MG of Children and Youth, Science and Research, Civil Society, Private Sector), Government and academic Technology Assessment Offices and centers, Engagement Mechanisms of the Committee on World Food Security (e.g. Civil Society Mechanism and Private Sector Mechanism), and Farmers' networks (e.g. La Via Campesina)

Submissions collected online by the secretariat and provided to multi-actor authors group.

Initial landscape report and clustering:

Cluster 1: Digital and Data-driven technologies:

Computer Assisted Organic Synthesis (CAOS), Synthetic Biology and cell factories, Online markets and online delivery, blockchains and fintech tools, algorithmic trading, molecular communication.

Cluster 2: Automation and Sensing:

Precision agriculture applications, drones, robotics (in the field, in processing and in food service), sensors and remote sensing technologies, LIDAR, 3D printing and additive manufacturing of food, animal and crop health sensors and actuators, pathogen/pest detection, hydroponics and 'vertical farming,' molecular communication.

Cluster 3: Molecular engineering (nanotechnology + biotechnology):

Nanomaterials, nanofoods, nanocoatings, nanopesticides, taste/sensory modification technologies, synthetic biology, gene editing, molecular communication, metabolic engineering, cell culture engineering of food (e.g. meats, animal proteins), Epigenetic engineering, gene drives, RNAI sprays, Microbiome engineering, Photosynthesis engineering, Nutrigenetics/nutrigenomics, animal vaccines.

Cluster 4. Earth Systems Engineering and ecosystem interventions

Weather and climate intervention, nutrient/nitrogen cycle engineering, water/hydrological cycle ag-microbiome engineering/biologics, food microbiome, Photosynthesis engineering. Sunlight radiation modification/geoengineering, soil carbon technologies, biochar, agroecology.

Stage 2: Situate

Identify technological and Innovation agendas relevant for food security, nutrition and agriculture:

1. Bioeconomy/blue economy – e.g. altering agriculture/aquaculture to maximise feedstocks.
2. Circular Economy – technological fixes for recapturing/recycling waste to food, nutrients, CO2, etc.
3. Precision Agriculture – data-driven efficiencies on the field and in livestock, replacing farmers.
4. Climate Smart Agriculture – functionalising industrial agriculture to increase CO2 sequestration, adapt to climate variability and expand range.
5. Advanced Manufacturing – flexible and efficient ingredient and food production.
6. Cellular agriculture/ "clean food" – lab production of animal agriculture products without animals.
7. Fintech – manipulating economics of supply to maximise value and efficiency.
8. Vertical farming – indoor agriculture, moving to intensive greenhouse/ hydroponic and urban production.
9. Personalized medicine/nutrigenomics vision – tailoring food to individual genetic profiles.
10. Agroecology/Organic production and 'local' food – low input, ecological-based agriculture.

Stage 3: Sample

Commission a sample of three or four in-depth case studies of technology applications affecting food security, agriculture and nutrition:

Case study 1 (Near-term): Synthetic Biology Cell Factories

Crosscutting Agendas: Bioeconomy, Circular Economy, Cellular Agriculture, Advanced Manufacturing.

Case Study 2 (Mid-term): Artificial Intelligence for On-Farm Automation

Crosscutting Agendas: Precision Agriculture, Circular Economy, Climate Smart Agriculture.

Case Study 3 (Longer-term): Molecular Communication

Crosscutting Agendas: Precision Agriculture, personalized medicine/Nutrigenomics, Climate Smart Agriculture, Fintech.

Stage 4: Assess

Possible participatory technology assessment exercises at this stage might include:

- Multicriteria mapping exercise across a basket of different technologies selected from Stage 1.
- "Red teaming" (debate) exercise on Synthetic Cell factories
- Citizens Jury on Precision Agriculture
- Scenarios Futures exercise to evaluate implications of Molecular Communication

Stage 5: Suggest

Question: To which policy and governance processes on food security, agriculture and nutrition should conclusions and recommendations be addressed?

International: e.g. UN Committee on World Food Security, UN STI Forum, IPES-Food (International Panel of Experts on Food Systems).

Regional: E.g. European Union Common Agricultural Policy, or Ninth Framework Programme

National or non-governmental: e.g. National Academy of Sciences Science, Breakthroughs 2030 Food and Agriculture Study

GOATS in the Technology Facilitation Mechanism?

Governments and others attending the STI Forum are encouraged to raise this proposal of GOATS as a possible vehicle for realizing the aims of the Technology Facilitation Mechanism. In particular, GOATS would address paragraph 275 of "The Future We Want" Declaration as well as obligations under Principle 9 and 10 of the Rio Declaration.

GOATS could be incorporated into the TFM in the following ways:

- Establishing a multi-actor GOATS process as input to the annual STI Forum – DESA, working with a multi-actor convening group, could oversee participation activities and the production of a thematically-tailored GOATS report in advance of each annual STI Forum.

- Integrating GOATS into the Global Online Platform. Outreach and participatory aspects of the GOATS process could be enhanced through the Global Online Platform. E.g. using wiki tools and Web 2.0 approaches to solicit and cluster knowledge, or carrying out online participatory technology assessment activities.

- Formal Input to The Global Sustainable Development Report. As a cross-cutting theme to the SDGs, technology will likely feature prominently in the Global Sustainable Development Report. Establishing a GOATS process could help structure the input on technologies as well as achieve the spirit of principles 9 and 10 of the Rio Convention (on capacity building, participation and access to information) as well as paragraph 275 of "The Future We Want."

Call for feedback and Engagement

ETC Group has prepared this draft proposal for STI Forum 2 New York, May 2017.

We would be happy to receive feedback, comments, suggestions:

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