The Case for a Global Technology Assessment

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The term Technology Assessment (TA) is a Western invention, but its purpose and methodologies are far from a Western exclusivity. The appeal of TA is universal since it is interlinked and indeed, it even depends on scientific and technological developments. One could argue that, where there is technology, there is necessarily TA. But the 'whens' and 'hows' in this relationship vary greatly from country to country and situation to situation. It is not a matter of whether TA is undertaken when science and technology develops and its results are applied in real life. The answer to such questions is always in the positive. Even if not termed as such, TA is evident one way or another since any kind of application is necessarily the result of an assessment. What matters is the timing of the TA, e.g. when is it done in the S&T development trajectory and predominantly, how it is done. There is tremendous variety in answering the 'when' and 'how' of TA and one is instinctively prone to view culture, values and politics realities as the main parameters in the answers. But, is this actually the case? Is TA evident in other parts of the world in a similar style with our Western approach to it? Whether yes or no, what are the actual parameters that impact its application? Is culture a significant dynamic in TA or are there other more important preconditions for its development? And, while looking at differences between regional developments around the globe, are we able to find any significant commonalities? Is a common, global TA possible at all?

This book represents a first attempt to provide answers to such questions. We say 'first' because we are not aware of a similar initiative elsewhere and 'attempt' because we are not trying to provide definitive answers. We are far from global solutions in every urgent matter that humanity is faced with, let alone TA. But as with every other aspect of common importance, S&T developments are borderless and so should TA be. As such, we are starting here the inquiry into how TA is done in various regions with examples from key countries around the globe.

The history of TA is well rehearsed but for the sake of the readers that are not so familiar with it, a short summary is provided here. Although TA activities have been part of S&T for a longer period, official TA (i.e. the activity termed as such) was established in the 1960s, focusing on concrete predictions of technological consequences. The main aim of this first TA was to gain advanced knowledge on technology options in order to create better informed policy decisions (Grunwald 2010). This was an 'early warning' system that was central to the identity of TA as it was seen as the means to identify potential hazards and minimize their effects. The first official TA agency in the world was appropriately named Office of Technology Assessment (OTA), and was specifically established in 1972 to provide scientific advice to the US Congress. The reasoning behind OTA was to contribute to the political decision-making process by delivering comprehensive knowledge on S&T consequences. In the words of its makers: "it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging problems" (United States Senate 1972).

OTA represented what came to be known as 'classical TA'. This is the type of TA whose functions are still valid within the TA discipline and which include the identification of impacts of technology, assertion of cause-and-effect relationships and the development of alternative programmes and options for action. This set the paradigm of TA as an information service, offering possibilities for activities but no prerogatives, in other words, to answer the what

'can' be done instead of what 'should' be done. It is not a coincidence that still nowadays the European Parliament's own TA bureau is called "Science and Technology Options Assessment"[1].

Soon after, European TA took up the US paradigm immediately and developed it further as it quickly became evident that TA cannot operate as hazard or risk analysis alone, if it is to provide functional policy advice. Classical TA was geared towards technocratic solutions to technocratic problems, but S&T had already become a social issue with considerable impact on the environment and the economy. Society changed from observer to participant and from recipient to actor. In this light, TA had to evolve towards new objectives and new methodologies to account for this change. What was then termed "participatory TA" was the answer to this necessary evolution. This new form of TA allowed for more complex analysis of S&T developments and a wider participation of actors.

Overall, TA was and still is, problem oriented research that aims to contribute to solutions of political, social, economic and environmental issues that are caused by S&T developments. The classical TA approach of transforming a scientific problem to a scientifically manageable research programme, has now been enriched with the inclusion of value-based criteria of analysis, that might or might not lead to a scientific solution. The idea of value neutral scientific advice and political decision-making cannot be kept up in modern societies. In this sense, the development of participatory TA is an effort to include these values in decisions and thus have a greater impact by involving society itself.

But even the spectrum 'classical – participatory' has not been able to satisfy the complexity of S&T challenges the world is faced with nowadays and the need to find sustainable solutions. TA methodologies have incorporated more innovative ideas in the effort to analyse the issues it deals with. Eclectic approaches such as constructive TA (Schot & Rip 1997), interactive TA (Grin et al. 1997), prospective TA (Liebert & Schmidt 2010) or, real-time TA (Guston &

[1] http://www.europarl.europa.eu/stoa/

Sarewitz 2002), have gone beyond the 'classical/participatory' dichotomy to develop action-oriented TA that has higher policy relevance.

If one should provide a categorisation of the modern TA state-of-art, three main areas of TA functions can be identified: TA as policy advice, TA in public debate and TA in engineering contexts (following Grunwald 2018).

TA as policy advice: This is the original aim of official TA since the times of OTA, i.e. to support policy-making by providing comprehensive and independent advice. This type of TA covers all technology aspects of public interest with particular focus on health and the environment. It aids in the identification of research priorities and the setting of the framework of innovation policy. This is the realm mainly of parliamentary TA that has seen considerable development in Europe, although the executive branch whether at national (e.g. ministries) or regional (e.g. municipalities) level has also taken up TA.

TA in public debate: Participatory TA is a category by itself as it involves a different paradigm of decision making than the standard policy ones. It is based on the view of citizens as active contributors to policy and policy itself as the result of deliberative democracy. This is an ideal view that incorporates all interests and values in an open public sphere of exchange and knowledge creation (Habermas 1992). The assumption in participatory TA is that both the effect and the legitimacy of the decision increases if the public is involved in the process.

TA in the engineering process: This type of TA encourages interdisciplinarity in the whole process of innovation. From the inception and design to development and market placement, TA plays a key role by enriching the process via a continuum of assessment. Reflexivity over possible consequences and account of a broader spectrum of values, helps the construction of quality engineering and can increase its societal and even economic worth (Guston & Sarewitz 2002).

So, what is actually TA? There is no such thing as a common definition since it is an interdisciplinary undertaking that seldomly had the opportunity to gather its great variety of expertise under a single entity. One such rare occasion under the European project "Technology Assessment; between Method and Impact" (TAMI)[2] produced the first ever common TA definition:

> *Technology assessment is a scientific, interactive and communicative process which aims to contribute to the formation of public and political opinion on societal aspects of science and technology. (Decker & Ladikas 2004)*

This definition contains many substantial aspects of modern TA. It refers to "opinion forming", not just "opinion informing" since it includes in its core competences the analysis of values and the participation of wide stakeholder representation. Although still true to its origins as a "scientific" process, it is also a "communication" process that aims to provide the means to overcome impasses in social debates. As such, TA not only does risk assessment, but also builds bridges between opposing views and values. Moreover, it is an "interactive" process because it sees interaction between disciplines and experts as key to its method. Finally, TA is a "social" endeavour as it focuses on aspects of technology which are relevant for society, whether in terms of ethics, environment or economics.

1 The Roles of Technology Assessment

In order to be able to compare the TA state-of-art across the globe, one needs more than a common definition. What TA does is a result of a number of pa-

[2] TAMI was a project European project from 2002-2003 focused on providing a basis for discussions on the methods and impact of TA. It brought together a unique group of European TA institutions and experts to systematically analyse TA activities and basic functions. For details see: https://www.itas.kit.edu/english/projects_grun02_tami.php

rameters that delineate its functions in a specific place and time. Before analysing these parameters, we need a common framework of TA functions that encompasses all possible aims and remits that TA could possibly have, in other words, what roles TA has across the globe. Following the consensual process of devising a common definition, the same group of TA experts have identified a common framework of TA functions (Hennen et al. 2004). Below is a matrix that shows nine types of impacts of TA and an inventory of 21 roles or functions of TA in policy making, developed by TA-practitioners.

Table 1: Typology of Impacts (from Hennen et al. 2004)

Impact Dimesion/ Issue Dimension	**I. RAISING Knowledge**	**II. FORMING Attitudes/ Opinions**	**III. INITIALISING Actions**
Technological/ Scientific Aspects	Scientific Assessment a) Technical options assessed and made visible b) Comprehensive overview on consequences given	Agenda Setting f) Setting the agenda in the political debate g) Stimulating public debate h) Introducing visions or scenarios	Reframing of Debate o) New action plan or initiative to further scrutinise the problem at stake p) New orientation in policies established
Societal Aspects	Social Mapping c) Structure of conflicts made transparent	Mediation i) Self-reflecting among actors j) Blockade running k) Bridge building	New Decision Making Processes q) New ways of governance introduced r) Initiative to intensify public debate taken
Policy Aspects	Policy Analysis d) Policy objectives explored e) Existing policies assessed	Re-structuring polcy debate l) Comprehensiveness in policies increased m) Policies evaluated through debate n) Democratic legitimisation perceived	Decision Taken s) Policy alternatives filtered t) Innovations implemented u) New legislation is passed

There are three overall dimensions of impact that TA could be expected to have: impact in the sense of **raising knowledge** on issues among policy makers or in public debate, impact in the sense of **forming opinions/attitudes** of actors involved in policy making and the debate, and impact in the sense of **initialising actions** taken by policy makers or other actors.

These dimensions are interlinked with the dimensions of the issues that TA is expected to generate knowledge about. It has to deliver comprehensive and unbiased information on the **technological and scientific aspects** of the issue that is at stake and in order to do this it must describe the **societal aspects**, meaning providing knowledge about the relevant actors and the possible social conflicts that can evolve around the technology under consideration. Furthermore, it must analyse the **policy aspects** of the problem and develop policy options.

Raising Knowledge represents the classical TA functions. It refers to the perceived deficit in knowledge of scientific facts that is sometimes seen as the cause of issue at stake. The three roles in the column Raising Knowledge are directly related to the content of the TA process and its outcome; these make relevant actors aware of new aspects of the issue. Examples of this are scientific knowledge on paths of technology development, risks, chances, unintended consequences etc. (**scientific assessment**), interests or perspectives of actors involved (**social mapping**) and problems and options of policy making (**policy analysis**).

TA is also a learning process amongst actors that not only raise their knowledge level but also change attitudes and opinions about the issue at stake. Forming Attitudes or Opinions is thus another role that TA can play. Changes in attitude may occur with regard to new scientific aspects which are now discussed among policy makers or in public debates (**agenda setting**). It may happen that the TA-process or outcome change the way that the relevant actors see each other or deal with each other (**mediation**) or that options for policy making are seen/discussed in another way or that new options become prominent on the agenda of policy making (**restructuring the policy debate**).

Initialising Action means that a TA process influences the outcome of the policy making process. Regarding the scientific aspects of the issue at stake a TA-process may lead to **new R&D policies**, such as initiatives to further scrutinise aspects of the problem. With regard to the societal aspects (e.g. actors, conflicts) policy makers may conclude from a TA-process to initialize **new ways of decision making** (e.g. to set up a programme of public discourse or include social groups in the decision-making process). Apart from such initiatives which can be seen as new forms of dealing with a problem it might well be that TA leads to a definite **political decision** (in the sense of closure of debate): e.g. to implement a technology that was scrutinised with regard to its pros and cons, or to set up legal rules for implementation.

2 Towards a Global Technology Assessment?

As the evolution of TA described above shows, it must react and adapt to continuously changing situations in which S&T take place. A next step in this is the global level. The aim of developing a global approach for TA comes from the growing need to assess S&T on a global level. This in turn emerges through a situation in which S&T are becoming more and more widespread in their development and effects. Technologies extend worldwide and influence the lives of people in very different countries or cultures almost simultaneously. Therefore, when looking at most developments (economic, cultural, technological, social, etc.) in our world today, the concept of globalisation is inevitable in order to better understand how these actually take place. Studies on the increasing global scope of changes have emerged since the 1970s, focusing on various developments such as the rise of a global economy, global cultural practices, political processes on a global level, the worldwide movement of people including new forms of identities and communities as well as new social hierarchies and forms of inequality (Robinson 2007: 125). The analysis of these global issues has been done in numerous areas ranging from

social sciences, history to law and natural and applied sciences. Overall, globalisation can be described as the intensification of social relations across the world, which links the local to events happening far away and vice versa (Giddens 1990). Yet, whether globalisation is a process or a condition, whether it is mainly economic, cultural or political remains contested (Robinson 2007: 127).

In light of global effects of science and technology as well as global challenges there is an increasing need to find methods and frames for coping with, but also shaping these developments. Next to more or less established forms of national TA, this calls for a searching of global approaches. The frame of TA is the orientation based on the problem at hand, which then determines the methods used or the addressees targeted. From the increasing relevance of global effects and challenges comes a further problem orientation for TA: How to respond to these (new) global transformations? In the context of global S&T developments and effects as well as challenges what forms of global TA are needed and what can a global TA framework look like? Scaling TA up to a global level also means to look for common ground: Which aspects of debates can be found in all countries or cultures dealing with S&T developments? But at the same time to look at how TA (or TA-like activities) are understood differently in countries.

Accounts on the shortcomings of TA[3] and possible new forms can be found, especially in relatation to sustainable development (Ely et al. 2011). TA has the potential to help prioritize and identify more effective or sustainable S&T policy decisions, but the critique here is that conventional TA often does not deliver, especially in the so-called developing world. In this case, TA, as a Western concept, may tend to give inadequate accounts of the existing social,

[3] General shortcomings and critique, especially of parliamentary TA can be found related to the first Office of Technology Assessment (OTA) established 1972 by Congress in the U.S.A. Here is was claimed that OTA lacked objectivity, was slow in assessing, limited view of consequences (focusing more on economic ones than on ethical or social effects) or lack of stakeholder involvement (Ely et al. 2011: 17; for more on OTA see for example: Bimber and Guston 1997).

technical or environmental situations or uncertainties and miss local power structures that shape S&T developments. This means that new forms of TA are needed, ones that "position technologies within dynamic pathways of change at the system level, recognise alternative understandings of these systems by different groups within society and attempt to build resilience in the face of pervasive uncertainty" (Ely et al. 2011: 10). These new models of TA should adapt to the world around them. They should combine participation of decision makers with citizens and technical experts. Moreover, they should be networked rather than central in their location (e.g. an office of TA). This can enable an opening of the output provided by TA to wider policy discussions as well as bringing wider inputs into the assessment[4]. The global level of new models of TA can be achieved through the inclusion of an array of organisations throughout the world, that can be included in TA activities. This idea goes beyond the old TA concept of a country-based and government-led activity, and redesigns it towards "more transnational, networked, virtual and flexible" (Ely et al. 2011: 21).

The apparent challenge of TA in today's world can be regarded as the need to be applied at a global level of assessment and result in corresponding global policies. Yet, this raises new questions in terms of how TA methods are able to incorporate and deal with numerous cultural differences, and what TA formats could have the potential to be useful in various cultural contexts?

3 Towards a Global TA Framework

The above shows the apparent need for a global TA. Based on this thinking, we need to further specify the parameters that effect such a possibility. In other words, what influences the creation of a common functioning TA across

[4] One example of a wider inclusion and taking action regarding technology development especially in the developing world is the Appropriate Technology Movement (Hazeltine & Bull 1999; Pearce 2012 or http://apptechdesign.org/).

the globe? As we have already witnessed in Europe, there are certain dynamics that are particularly important in the development of TA. These are contextual influences that delineate the positioning and function of TA. As our aim is to develop a common TA framework, it is vital to reach as much commonality as possible in the context that TA functions in. This is needed in order to be able to develop meaningful national comparisons, but also in order to be able to approach the analysis of common challenges on equal footing. This is not to say that we argue for an identical TA around the world; that would simply be impossible and not desirable. We should nevertheless strive for a critical mass of commonalities that can create a common framework in which TA can function.

Institutional Setting

Commonalities can be found in the way that TA is understood and structured across the globe. The institutional setting of TA is one aspect that deserves attention since it has significant repercussions on how it is viewed and functions. This refers to the particular organisational structure of the TA institute (or similar organisations), such as the mission, location in the decision-making system, clientele and image (Cruz-Castro & Sanz-Menendez 2004).

The foremost contextual parameter is whether the TA institute is directly attached to the national legislature, i.e. whether it is "parliamentary TA". In Europe, there is a number of TA institutes that belong to the official national legislature structures, prominently in Germany, France, Norway and Switzerland. No such TA settings exist in non-European legislatures. Alternatively, the TA institute could have a more independent status as an academic research institute with an additional policy advisory role. The difference in this setting creates clear limitations in the TA process and the impact of its work.

It is important to note here that the content of the work does not necessarily change due to the location of the institute. We have examples of parliamentary institutes that are very active in initiating public debates, running participatory processes and function as bridge-builders (e.g. in Norway) and also

non-parliamentary institutes that focus on S&T analysis and options assessment via research programmes (e.g. in Germany). This diversity though does not invalidate the overall distinction, since the main client is different in these cases: a parliamentary office can only work on issues that are of interest to the national parliament and in ways that the members of the parliaments have sanctioned. And although by no means guaranteed, there is normally a direct input in the decision-making process.

Policy paradigm

The policy system that dominates the country in which TA is functioning, naturally poses strong influence in its functions and working dynamic. This does not necessarily refer to political economy, since nowadays it is hard to find direct connection between political economy and S&T developments. This is not to say that S&T is free from ideology; far from it. But the facts show that whether nominally communist or capitalist, central planning or free market led, a country that advances its S&T system faces similar issues and challenges. The policy system affects the way that TA works via the decision-making structures and the main actors in them, in other words in the way innovation is conceived and promoted.

State versus market driven innovation, is a basic distinction that has a direct impact in TA functions. Where the state is the prime mover of the innovation system, public organisations have the main say and are the main funders of S&T developments. TA, as an established public service with independent scientific credentials, has a key role in influencing policy-making. Its proximity to the state can be a benefit in such an innovation system, so long as its independence can be assured. State-driven innovation should ideally be geared towards the public good, free of political bias, and this can provide TA with a direct influence in policy-making.

In a market driven innovation system, S&T developments are led by private initiatives. Profit is naturally the main motivation, but this need not be in conflict with the public good. Market decisions are influenced by social needs,

therefore issues of risk, acceptance, sustainability and fairness play a significant role. TA plays a double role here: either as an independent assessor tasked by market forces or as a legislative advisor on the behest of public bodies. In any case, in a market driven system, hazard identification (for health or the environment) are predominant issues in the TA process.

Values systems

Similar, but not identical, to the policy system, TA is influenced by the dominant values that are evident in each society. By values here, we mean the standard social norms of behaviour and the overall understanding of right and wrong. This is usually expressed through traditions, religious beliefs or political ideology. This is a context that cannot be disregarded when analysing S&T developments and attempting to provide realistic and sustainable options for action. Although this is not a straightforward undertaking and it also requires input from additional social scientific disciplines such as anthropology, political sciences and sociology, the analysis of the dominant values in society that influence the views and debates on new technologies, is a necessary ingredient in a global TA. In-built in this process, is the study of basic cultural influences in S&T developments that can be undertaken through the analysis of key policy documents (e.g. constitutions, strategy papers), relevant surveys (e.g. on S&T ethics) and input from key actors (e.g. Ladikas et al. 2015).

Innovation Development Stage

The state of the innovation trajectory in the particular area of analysis, is another important factor in the operation of comparative TA. This refers to the concept of timing in the innovation process and how that effects the assessment of new technologies. As a rule of thumb, the earlier TA enters the innovation trajectory, the more possibilities there are to shape the future of the technology at stake, but at the same time, the more partial and imprecise the available information is. On the other hand, the later TA enters the trajectory, the more complete and comprehensive the knowledge over the technology is, but at the same time, there is less influence in the innovation strategy.

There is no obvious solution to the problem of timing and it is also not directly related to institutional settings. The location of the TA institute in the decision-making structure does not necessarily help it to identify the right time in the innovation trajectory for assessment. It is actually not uncommon that policy structures are too inflexible to recognise the potential trajectory of a particular technology and as a consequence, are not able to initiate a policy relevant TA analysis. A possible solution is to be found in enhancing the internal institutional flexibility to take advantage of individual experience and knowledge of the innovation context.

Science and Technology Priorities

Not every country has the same S&T priorities. Despite the fact that there are so many global problems that need global solutions, each country also has unique needs that require specific solutions. Technological development is interlinked with socio-economic development and although there is no rule on which technologies are appropriate at which stage of development, there are certain commonalities that need to be taken into consideration. For instance, nanotechnologies are providing countless opportunities for product development but also result in very similar challenges (e.g. unintended health or environmental hazards) that TA is required to assess. At the same time, countries like Germany develop health applications (e.g. drug delivery) while other countries, like India, focus on environmental applications (e.g. water filters). The reason for this discrepancy is simple: different needs and expectations. A global TA has to take into account the different priorities created by different socio-economic needs, which in turn result in different challenges.

4 The Scope of this Book

It is clear we cannot provide in this book a definitive global perspective but instead, 'a' global perspective. To start with, global perspective means full global representation that we do not have in this book. It also requires empirical research that we do not undertake here either. What we do is open up the discussion by describing how TA is being done in a number of key countries with intensive S&T programmes, and offer perspectives on how a global TA could be applied and which vital ingredients it should have.

China, India, Australia, Russia and Germany have been chosen as case studies in TA. There is an obvious reason for this: all these countries have a strong S&T sector and economies that are partially, if not predominately, based on it. The need for TA is evident and they represent a spectrum of TA developments. From countries with a strong, well-established TA presence (Germany) to those with limited experience in it (China, Australia) to those with little knowledge in it but with experience in similar processes (India, Russia). They also represent very different policy systems, cultures, values and socio-economic trajectories. These are all key issues in our inquiry.

One can reasonably argue that there are other interesting countries, representing different TA experiences, policy systems or cultures. Countries that one cannot disregard in a global TA perspective. This is of course true and there is a slight 'EurAsia' bias in the choice of countries. But one should start from somewhere and our choice is very useful for the purposes of this book. If one understands how TA functions in such diverse countries, then one can start devising a common global framework. This is the first step towards a global TA. This is our aim.

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