Technology Assessment in China

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1 Science and Technology Policy Structures and Technology Assessment

The People's Republic of China is the largest populated country in the world, with around 1.4 billion people[1] and is located in East Asia. The capital is Beijing, the largest city is Shanghai. China is a unitary republic and is governed by the Communist Party of China in 22 provinces, five autonomous regions, four municipalities and special administrative regions (Hong Kong and Macau). Economic reforms in the late 1970s resulted in rapid economic growth, China is the second largest economy by nominal GDP (an estimated $11.938 trillion in 2017) and the largest worldwide by purchasing power parity ($23.122 trillion).[2] This has led to the development of a middle-class of about 300 million and to China having the world's second highest number of billionaires[3]. Since 2010 94% of the Chinese population over 15 years is literate, as a comparison in 1949 only 20% of the population could read[4]. In connection with these economic strides is the development of science and technology. In recent years

[1] https://esa.un.org/unpd/wpp/DataQuery/

[2] http://www.imf.org/external/pubs/ft/weo/2017/02/weodata/weorept.aspx?pr.x=89&pr.y=14&sy=2016&ey=2018&scsm=1&ssd=1&sort=country&ds=.&br=1&c=924&s=NGDPD%2CPPPGDP%2CNGDPDPC%2CPPPPC&grp=0&a=

[3] https://en.wikipedia.org/wiki/China#cite_note-BBERG10012014-382

[4] https://data.worldbank.org/indicator/SE.ADT.LITR.ZS?locations=CN

China has widely invested in S&T: $163 billion in 2012[5] and $233 billion in 2016, which is about 2.1% of the GDP[6]. The country is second in the number of scientific publications and first in PhD engineers. Overall, S&T is an important part of national identity and integral part of achieving economic and political goals. These vast developments, economically and socially, provide an interesting setting regarding how S&T policies are made. China has changed rapidly over the last decades and S&T have been an essential part of this. In the following the structures and values surrounding this will be described. Also, this will lead the way to a description of current TA practices in China, their location as well as what future needs could be.

Policy making for S&T in China is part of the bureaucratic system, which formulates and implements policies in general[7]. S&T policies, like others, take shape through the interactions between scientific and political institutions, in which actors from the legislative, government, advisory bodies, conducting or funding organisations all play roles. The parliament and the highest level of state power, the National People's Congress (NPC) by use of the Standing Committee and the Committee on Science, Technology, Education and Health "has the authority to draft, enact, and amend S&T-related laws, which usually are drafted by a specific government ministry. Technically speaking, NPC also monitors the implementation of such laws and approves the state budget for science and technology affairs. Members of the Chinese People's Political Consultative Conference (CPPCC), an advisory body, many being non-Chinese Communist Party (CCP) member scientists and engineers, also voice their expert opinions and comments" (Liu et al. 2011: 919).

In the centre of the S&T government enterprise in China is the Ministry of Science and Technology (MOST), which conducts China's national S&T pro-

[5] https://www.bloomberg.com/news/articles/2014-10-01/chinas-163-billion-r-and-d-budget
[6] http://english.cas.cn/newsroom/china_research/201710/t20171020_184378.shtml
[7] In March of 2018 the Chinese government issued a plan to reform the institutions of the government.

grams, including basic and applied research, commercialisation of S&T, backing of innovation within companies as well as support of science parks and incubators (Liu et al. 2011: 919). Correspondingly the mission of the Ministry reads: "MOST takes the lead in drawing up S&T development plans and policies, drafting related laws, regulations and department rules, and guaranteeing the implementation […] MOST aims to serve socio-economic growth by coordinating basic research, frontier technology research, research on social service, key technology and common technology."[8] Here we again find close ties between S&T developments and economic growth.

A further important actor is the Chinese Academy of Sciences (CAS), which has a large advisory role to play regarding S&T policy making through its academicians providing services for decision making. CAS is active in "research, high-tech development, technology transfer, and training" (Liu et al. 2011: 920). In its own mission CAS understands itself as "the linchpin of China's drive to explore and harness high technology and the natural sciences for the benefit of China and the world […]. Since its founding, CAS has fulfilled multiple roles — as a national team and a locomotive driving national technological innovation, a pioneer in supporting nationwide S&T development, a think tank delivering S&T advice and a community for training young S&T talent"[9]. CAS sees itself as driver for indigenous innovation and S&T developments in China as well as taking on an advisory role for policies in these areas.

Another central player is the National Natural Science Foundation of China (NSFC), which "mainly supports basic research and mission-oriented research projects through competitive and peer review processes" (Liu et al. 2011: 920). The NSFC is the institution which administrates the National Natural Science Fund for the Central Government, "supporting basic research, fostering talented researchers, developing international cooperation and promoting socioeconomic development"[10]. The administrative system in NSFC aims to

[8] http://www.most.gov.cn/eng/organization/Mission/index.htm
[9] http://english.cas.cn/about_us/introduction/201501/t20150114_135284.shtml
[10] http://www.nsfc.gov.cn/english/site_1/about/6.html

improve decision-making in funding policy and implements as well as it monitors and consults. Also, here we find connections made between the economic developments for society and the importance of S&T for this.

The Chinese Association for Science and Technology (CAST) can be regarded as an umbrella organisation made up of various academic and professional societies (Zhu 2009: 72). It understands itself as the "largest national non-governmental organisation of scientific and technological workers in China, which also serves as the bridge that links the Communist Party of China and the Chinese government to the country's science and technology community"[11]. The societies of CAST, over 200, spread throughout China and allow for a wide network in the area of S&T. Overall, CAST is an important player in driving Chinese S&T development and has participated in shaping policies and regulations through its networks of scientists, engineers and other people working in S&T. Close ties to policy and decision making are provided by the constituent membership of CAST in the CPPCC. In its mission statement CAST describes itself as an organisation aimed at developing S&T in China, opening S&T up to a wider public as well as providing advice for the overall S&T strategies: "CAST devotes itself to boosting the development of science and technology in China and enhancing science literacy of the whole nation, organises and encourages scientists and engineers of the country […] to conduct academic exchange, science popularisation and scientific and technological consulting and other activities according to the country's science and technology development strategy, accelerate the emergence of scientific and technological talents, voice the opinions of science and technology professionals and firmly safeguards their legitimate rights"[12]. Again, we see here the alignment between strives in S&T and the development of China as well as communication and promotion of S&T in different areas. These organisations derive their legitimacy and standing from their activities for enhancing the development of S&T in China as a way to support the development of the country as a

[11] http://english.cast.org.cn/n214206/n214353/index.html
[12] http://english.cast.org.cn/n214206/n214353/index.html

whole. In this way, we find close links between the self-understanding of these organisations and the well-being and development of China.

1.1 Main Advisory Structures

In China, each main actor in the S&T decision making system has its own S&T policy research institution functioning as an advisory organisation constantly reviewing, evaluating S&T projects and drafting S&T plans. The following describes the institutions that can be considered to have TA-like roles within the Chinese system.

The Chinese Academy of Science and Technology for Development (CASTED), affiliated to MOST, is a key actor in providing policy advice for S&T and is therefore engaged in many TA-like activities. CASTED contributes to decision making by participating in the "formulation of all important national S&T strategies and plans, and has played crucial consultation and support roles for our S&T development" (International Innovation: 1). CASTED focuses on the development of an innovative society, the improvement of innovation capacities as well as on the provision of advice for a macro decision making level regarding S&T development. This also includes the societal level of S&T developments, "taking into consideration social needs and realities" (Zhu 2009: 77). CASTED's key aims include providing studies and suggestions for the design of national S&T development strategies, conducting research for central and local government departments supporting national strategic decision making and policy, development of a core S&T strategy talent team as well as setting up an exchange platform to connect different research resources, networking international and national research. Further, the academic set up of CASTED, ranging from natural sciences, engineering, economics or sociology reflects an interdisciplinary approach needed for assessing S&T and providing advice. CASTED is made up of various institutes with one explicitly focusing on the relationship of S&T and society. The Institute of Science, Technology

and Society at CASTED "studies S & T-related social development issues, including social science studies on risk and disaster, social environment of innovation, studies on scientific community, education, employment, non-governmental organisation, and frontier issues such as innovation culture, science ethics, and S & T and social inequality"[13]. Further, it assesses the social impact of S&T projects and gives policy advice also on sustainable development. These characteristics of CASTED show a close relation to TA or TA-like activities. Examples for TA-like activities include a national soft science program, which established an open exchange and stakeholder communication platform enabling debates on policy issues and expanding the consultation process. Another example is a foresight project on high-tech industries in China aimed at examining different fields of technology, which are of importance to social and economic development in China. Socioeconomic needs were analysed, surveys on stakeholder opinions were undertaken and a comprehensive investigation on the benefits and problems was conducted. This wide consultation and the focus on societal needs were unique parts of the foresight project, which helped identify national priorities and crucial developments (Zhu 2009: 79ff.).

The Institute of Policy and Management (IPM) of CAS established in 1985, offers research consultative services to central authorities, CAS, local governments as well as businesses. Its research areas include S&T strategy and planning; science, technology and society; S&T management and evaluation; intellectual property and S&T law; innovation and development policy; innovation and entrepreneurship policy; sustainable development strategy; energy-environment-economy; overall planning and management; policy modelling and simulation; urban development and regional management; and interdisciplinary studies of natural and social sciences. Sticking to key topics concerning national strategies of sustainable growth and rejuvenating China through science, technology and human resource development, IPM conducts strategic studies and offers strategy options with an important bearing

[13] http://2015.casted.org.cn/en/web.php?ChannelID=67

on the country's development by taking advantage of its academic build up in integrated and interdisciplinary studies, and renders strong support to make China a harmonious and innovation-driven society. Since its establishment, IPM has scored a large number of widely-acclaimed research achievements. Its annual report series, including the China Sustainable Development Report and the High Technology Development Report, have rendered support to the drafting of important national policy documents, such as an Outline for the National Medium- and Long-Term Program for Science and Technology Development (2006–2020) and the 12th Five-year Plan for Innovation Capacity Building in China.

The main responsibility of the Bureau of Planning within NSFC is to elaborate plans of NSFC, to comprehensively coordinate and direct the allocation of the funds, to compile the Guide to Programs and establish related criteria for compilation, to formulate guidelines for the application, evaluation and financing the projects funded by NSFC, to make comprehensive statistics and analysis on the achievements of the funded projects and to manage NSFC's peer review system, to manage the archives of the funded projects, to manage the local liaison units of NSFC. Another institution within NSFC is the Bureau of Policy, which analyses and studies the trends and funding opportunities for basic research in natural sciences at home and abroad. Further it analyses disciplinary policy, studies and establishes strategies, guidelines, and policies for the development of NSFC, proposes measures for perfecting the management system as well as operation mechanisms and assessment systems of NSFC to verify NSFC's regulation documents and coordinate the formulation of related policies. In addition, the Bureau of Policy is mandated to provide consultancy concerning significant S&T policies and to draft policy statement of NSFC.

The China Association for Science and Innovation Strategy Research Institute (NAIS) was established in August 2015, is directly under CAST. It's main responsibility is to focus on the strategic objectives of the national science and technology development, on the assessment of national-level innovation,

commitment to national scientific and technological innovation and development strategies, planning, plans, projects, bases, personnel, projects assessment tasks around the science and technology policy, science and technology human resources, science and culture, and science and technology development research community, for the community to provide third-party professional consulting and evaluation services, promote the establishment of a sound national science and technology assessment system to create a high level of technological innovation influential think tanks and international reputation.

Next to these institutions with various TA-like activities the China National Health Development Research Center (NHDRC), previously known as China Health Economics Institute (CHEI) can be named as well. It is a national research institution, established in 1991 under the leadership of National Health and Family Planning Commission of China (NHFPC) and works as a national think-tank providing technical consultancy to health policy-makers to further strengthen health policy research and better accommodate the needs of health development and reform. CHEI formally changed its name to the China National Health Development Research Center in 2010 after being approved by the Chinese Staffing Committee. NHDRC has a Division of Health Technology Assessment (DHTA), conducting health policy evaluation and technology assessment. Research Fields of DHTA include: impact evaluation research on health and family planning policies, public health programs and providing policy-makers with solid evidence on policy outcome as well as conducting assessment on the appropriateness of health technologies and advanced medical devices to serve decision-making over choice of appropriate technologies.

Further, The China Institute for Science and Technology Policy at Tsinghua University (CISTP), one of the top universities, was jointly founded by the Ministry of Science and Technology of China and Tsinghua University in 2003. It aspires to become a leading institution in S&T policy and development strategy through its research and educational activities. This includes monitoring S&T development trends and international S&T policy changes, engaging in academic research in S&T policy, providing graduate education and

short-term training in S&T policy, facilitating international cooperation and communication between the domestic and international S&T policy community and providing consulting services to the government and industry in relevant areas.

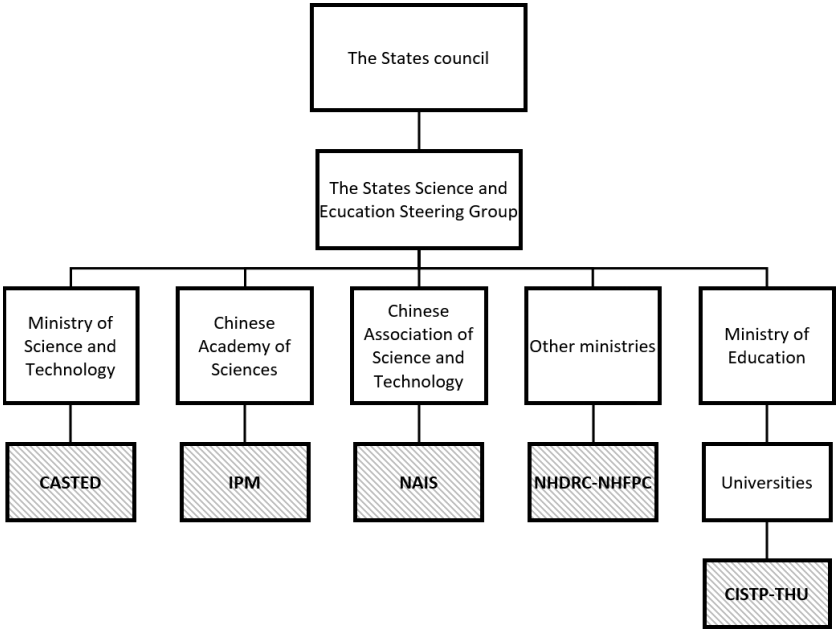

Figure 1: General structure of institutions. Areas of TA activities marked (own graph)

Overall, it can be stated that CASTED as it is directly affiliated to MOST is closer to decision making system and is more familiar with innovation policy and strategy making than other institutions. IPM is more academically oriented. This is because it is located within the CAS system and as such closer to research institutes and scientists. In general, NSFC is mainly focused on basic research. NAIS as part of CAST has close relationships with many other academic associations and societies. Beyond this, it also has access to scientific

personnel in universities, research institutes, and enterprises including scientists, engineers, doctors, teachers, etc. Figure 1 gives and overview of main institutions and in which one's TA activities take place (marked).

1.2 The Role of Technology Assessment

TA as such does not exist in the Chinese system. Yet, as seen from the descriptions above, various TA-like activities take place in different institutions. These range from evaluation of research to monitoring of innovation or health assessment, often with a connection to global developments and competition. Not very pronounced are activities regarding the involvement of the public or stakeholders. In this way TA activities in China fit into the top down structure in which targets or policies are formulated at the top level (e.g. NPC) and then trickle down. Therefore, TA's role can be understood as part of this system, which places high emphasis on the further development of S&T in order to better China's competitive position or solve large societal issues. Evaluation and monitoring of policies, research, etc. are an important part of enabling these goals. In this sense TA's role in the overall structure tends to be that of a "reviewer" of these initiatives, often looking at the quantitative evaluation of future S&T developments. With the influence of a drive for economic growth, assessing a technology in China is often understood as measuring its economic or innovative potential. From a European understanding of TA, with its significant focus on societal aspects, the Chinese context would require a new term, not a simple translation. This is because the literal translation is mainly focused on the economic potential in the sense of an evaluation. Therefore, the use of the term TA if understood as it is in the European discussion, would require an addition or concretisation in Chinese to include the societal aspects and the possible impacts of S&T on society, stakeholders, etc. Therefore, TA in China is mainly understood as an evaluation of future (economic) outcomes of S&T also in a competitive situation with other countries. In recent years, with the development of China entering a new era, the

government has paid more and more attention to the issue of unbalanced development and promoted the comprehensive development of economy and society. In the government departments, research institutes and social organisations a group of think tanks has been established. They are doing research with a combination of expert advice and social surveys continue to provide policy recommendations for policy-making departments. The research networks and platforms formed between these various types of think tanks will probably be the best areas for conducting technology assessments. Currently, CASTED seems like an appropriate place for TA to be further developed. This is due to is location as part of MOST, which gives it direct ties to decision making in S&T. Also, CASTED is active in technology foresight with a department in this area. Here the social-economic needs and S&T development trends are assessed using methods such as Delphi surveys, scenario analysis and technology road-mapping. Based on this, priorities of crucial technologies are set for policy making, especially for national S&T plans and for evaluations of high-tech developments. Though TA is not part of these foresight activities, it could be incorporated within CASTED.

2 Science and Technology Priorities and Values

2.1 Main Priorities in National Documents

In the Chinese system, there are several relevant official documents that show current priorities in S&T policies. The *National Long-Term Science and Technology Development Plan* (2006-2020) identifies 11 key areas for national economic and social development and selects from among them 68 priority topics that are likely to gain technological breakthroughs in the near future. The 11 key areas include: Energy, Water and mineral resources, Environment, Agriculture, Manufacturing, Transportation, Information Industry and Modern Services, Population and Health, Urbanisation and Urban Development,

Public safety and National Defence. These key areas refer to industries and industries that focus on the development of national economy, social development and national defence and are in urgent need of support from science and technology. The priority topics refer to the technical group that needs urgent development in the key areas, clear tasks, good technical foundation and that can make breakthroughs in the near future. The determination of the priority topics follows these principles: First, it is conducive to breaking the bottleneck constraints and improve the sustainable development of economy. The second is conducive to master the key technologies and common technologies, improve the industry's core competitiveness. Third, it is conducive to solving major non-profit scientific and technological issues and improving public service capabilities. Fourth, it is conducive to the development of dual-use military and civilian technologies and the improvement of national security capabilities.

Further, the *13th Five-Year Plan for national development of science, technology and innovation* issued in 2016 focuses on building up national advantages and strengthening the strategic layout of both the present and the long term. For this, China will speed up the implementation of major national science and technology projects and start the "2030-Major Project of Scientific and Technological Innovation", build an industrial technology system with international competitiveness, strengthen the integrated deployment of modern agriculture, develop next-generation information technology and smart manufacturing and energy, promote disruptive technologies and innovation as well as speed up industrial transformation. Also, this plan aims to improve the technical system that supports the improvement and sustainable development of people's livelihood, break through bottlenecks in areas such as resources and the environment, improve population health and public safety and establish a technical system to safeguard national security and strategic interests as well as develop deep sea, deep earth, deep space and other areas of strategic high technology.

This five-year plan is based on certain principles, which show how the role of S&T is understood in policy making in China. These are summed up in the following:

(1) Adhere to supporting the country's major needs as a strategic task. Focus on the major needs of the national strategy and economic and social development, clearly define the main directions and breakthroughs; strengthen the core of common technology research and development and conversion applications; give open spaces to science and technology innovation for fostering and developing strategic emerging industries, promote economic upgrading and efficiency enhancement, leading the development of and the important role of safeguarding national security.

(2) Oblige to accelerating catching-up as the focus for development. Grasp the development trend of science and technology in the world, advance the planning and layout in the long-term development of the relationship, implement the asymmetric strategy, strengthen the original innovation, strengthen basic research, work hard in the original creation and comprehensively enhance the capability of independent innovation, and in important science and technology fields Achieve leapfrog development, keep up with and even lead the new direction of world science and technology development and master the strategic initiative of a new round of global technological competition.

(3) Science and technology for the people should be the fundamental purpose. We must closely follow the immediate interests and urgent needs of the people, integrate scientific and technological innovations with the improvement of the well-being of people and bring forth the scientific and technological innovations in improving people's living standards, enhancing people's scientific, cultural and health qualifications, promoting high-quality employment and entrepreneurship, helping the poor and poverty reduction and building a resource-saving environment-friendly society, so that more innovations will be shared by the people and they will have an increased sense of improvement.

(4) Insist on deepening reform as a powerful incentive. The reform of the scientific and technological system as well as the economic and social fields are essential. The decisive role of the market in allocating innovative resources should be accounted for as well as the role of the government in strengthening the market-oriented mechanism for technological innovation. This includes breaking down institutional barriers to enable in-depth integration of science and technology and economy. Support of breakthroughs and transformation of achievements are important and can form a dynamic mechanism for the management and operation of science and technology and further provide sustained momentum for innovation and development.

(5) Talent is an essential requirement. A priority development strategy for talented people should be implemented in order to put the development of human resources at the highest level of science and technology innovation. This includes finding qualified personnel in innovative practices, cultivating qualified personnel in innovative activities, fostering talent pools in innovative undertakings, reforming the mechanism for training of qualified personnel, and developing a large-scale structure to guarantee excellent quality of personnel.

(6) The global vision is an important guide. Take the initiative to integrate the global innovation network, optimise the allocation of innovative resources on a global scale, integrate scientific and technological innovation with the national diplomatic strategy, promote the establishment of a broad range of innovative communities and carry out scientific and technological innovation and cooperation at a higher level. This will help the aim of striving to lead in several important areas as well as becoming an important voice of discourse in global innovation governance.

These principles or characteristics show the importance of developing S&T in China, which is connected to the well-being of society and solving various challenges. It also become clear that China as a developing country is focused on “catching-up”, even becoming a leader, and sees the global level as a reference for this development.

Another important document is the *13th Five-Year Plan for the development of Chinese Academy of Sciences* (2016-2020). It identifies 8 major areas of innovation, which somewhat overlap with the other priorities described above. These areas are: basic and frontier crossing research areas, advanced materials, energy, life and health, oceans, resources and ecological environment, information, optics, electricity and space. The plan also places its priorities in the context of the needs of society such as areas of health and sustainability as well as economic and social development or national security. CAS's aim is to take on a leading and key role in China's major scientific and technological challenges also by focusing on modernisation and produce original achievements that have symbolic significance in building an innovative country. This includes approving of major strategic technologies and products that show output and benefits for more effective and middle-to-high-end technology supply in order to increase international competitiveness in S&T.

As these documents illustrate there are aspects, which are dominant in the debates on S&T policies in China. These are often understood in the context of societal challenges and how the further development of S&T and innovation can help tackle these, which is often the case in such strategic documents. Specific underlying values and principles, such as a strong belief in development or relying on S&T to solve problems, also show in these documents. This can be related to the idea of developmentalism, which is a key aspect in China (Zhao & Liao 2016). A strong belief in S&T (scientism) as well as top down management provide the basis for how these documents described policy approaches specific to the Chinese context. China has made great strides regarding the advancement of S&T, becoming an important global player. These documents reflect the drive to enhance national S&T also as a way to remain competitive.

2.2 Values leading S&T Debates

Underlying the priorities described in the S&T plans are overall values in the Chinese context. These can be found in the Constitution and have developed over time. Historically, mainly three influences regarding current values can be identified: "traditional Chinese values, Western values imported since 1840, and new values grown in contemporary Chinese society" (Ma et al. 2015: 75). Traditional Chinese values are influenced by the culture of Confucianism-Buddhism-Taoism, which focuses on the individual as the basis of judgments and extends this to a wider scope (e.g. to the family, to the state, even the entire world). This takes the value system from the individual and extends it to community. Modernisation on a global level made it steadily possible for Western values to come to China, including an affinity for Western S&T, ideas of freedom, equality, or prosperity as well as "concepts of rights and legal awareness has taken root in Chinese society and constitutes an important criterion for value judgments by the public" (Ma et al. 2015: 75). In contemporary China, the socialist market economy has created new conditions which also bring about new values. These are somewhat conflicting between socialist ideals of common prosperity and harmony and market-oriented principals of individual success and competition, yet they also have a common denominator of economic development. Further, the values surrounding the concept of sustainable development have also had influence. This describes briefly the context of the Chinese Constitution and the values conveyed in it. Beginning with the depiction in Article 1 the Constitution describes that "The People's Republic of China is a socialist state under the people's democratic dictatorship led by the working class and based on the alliance of workers and peasants". The socialist economic system is based on the idea that "socialist public ownership of the means of production, namely, ownership by the whole people and collective ownership by the working people" (Article 6). Article 7 describes that the "State-owned economy, that is, the socialist economy under ownership by the whole people, is the leading

force in the national economy". This relates to the traditional values of collectivity described above, in the sense that this socialist approach puts the collective interests of society at its centre moving past limits of individuals.

The main values in the Chinese Constitution can be described as: progress, affluence, peace and safety as well as harmony[14]. Progress towards a higher stage (e.g. from capitalist to socialist to communist society) has a key position in the Constitution, finding its expression in Article 14: "The state continuously raises labour productivity, improves economic results and develops the productive forces by enhancing the enthusiasm of the working people, raising the level of their technical skill, disseminating advanced science and technology, improving the systems of economic administration and enterprise operation and management, instituting the socialist system of responsibility in various forms and improving organization of work". Here we see a close connection between economic and educational progress and the well-being of society as a whole. Further the importance of S&T in the context of progress is emphasised. In order "to improve productivity and the development of productive forces in society, it is necessary to popularise knowledge of and skills in advanced science and technology […] enthusiasm and support for scientific progress serve as manifestations of the importance of this concept of value" (Ma et al. 2015: 77). Affluence is a further important value represented in the Constitution, especially regarding modernisation and advances in industry, agriculture, defense, education, S&T. Here the connection is made between development in these areas and overall improved living standards for citizens as well as Chinese independence and self-reliance. Article 20 states that: "The state promotes the development of the natural and social sciences, disseminates scientific and technical knowledge, and commends and rewards achievements in scientific research as well as technological discoveries and inventions". The connection between affluence, the well-being of society and

[14] The 12 core socialist values, which summarise the nation, society and individuals, comprise a set of moral principles, were defined by central authorities at the 18th National Congress of Communist Party in 2012, including: prosperity, democracy, civility, harmony, freedom, equality, justice, the rule of law, patriotism, dedication, integrity and friendship.

S&T and innovation can be seen in the focus on strengthening indigenous capabilities. The values of peace and safety have a longstanding tradition in Chinese society, giving an importance to citizens' health in the constitution (e.g. Article 21). Harmony in the sense of a coexistence of humans and nature gives issues of sustainability an important role ("The state protects and improves the living environment and the ecological environment", Article 26). This is also extended to a harmonious society, as (Ma et al. 2015: 79) describe a speech given by then president of China Hu Jintao. The characteristic of a society in harmony include: "democracy and the rule of law, fairness and justice, integrity and friendliness, vigour and drive, peace and order, and harmony between man and nature". With rapid economic development in China, this can be problematic especially regarding environmental issues, yet at the same time the values around harmony frame the reactions to these challenges. These values are the frame under which the Constitution can be understood and which form its basis. They also form the basis of policy decisions made by the government as well as how these decisions are regarded by society as a whole. In the context of S&T, "Progress, affluence, peace and safety, and harmony are the four values identified in the Chinese Constitutions that relate to people's ethical considerations of science and technology development" (Zhao & Liao 2016: p. 80) and therefore form important reference points.

The Constitution shows the main values and emphasizes what China as a country stands for politically and culturally. Regarding the recent rise of China as a global actor, the economy is of main significance here. This in turn also relates to S&T developments. China has emerged as a major player in the world economy expanding by an average of 10% a year over the last decades, rising as a major exporter, increasing its income per capita. "China's 'open door' policy has been an integral part of economic reform. Adopted in 1978, it has resulted in a progressive opening to foreign trade and investment and culminated in China's accession to the World Trade Organization (WTO) in 2001. Through its acceptance of globalization, China has become the most open of the large developing economies. In some respects, China today is more open than a number of significantly more developed market-based

economies" (OECD 2007: 11). Overall, the Chinese economy has gone from an agricultural to a services one, based largely on manufacturing. Regarding S&T, "China has relied heavily on technology imported from abroad, and the development of its scientific and technological capability has until recently lagged behind its economic growth. This trend was reversed towards the end of the last decade and since then significant progress has been made towards developing the country's innovative capabilities" (OECD 2007: 9). The close connection between the economic development and strives in S&T and innovation is not only limited to the Chinese context. Often S&T policies are closely connected to the aims of pushing S&T developments, coming to more innovations and eventually achieving more economic growth. Together with the decision to reform the economic system, "institutional reform of the S&T system was launched in 1985. The primary goal was to overcome the separation of R&D from industrial activity, the key shortcoming of the pre-reform S&T system [...] these reforms gradually enhanced the economic orientation of the S&T system by introducing elements of competition and market discipline. Major institutional innovations have included the establishment of a variety of government R&D programmes, the emergence of markets for technology and of non-governmental technology enterprises" (OECD 2007: 44). We see here the close ties between economic goals and corresponding S&T policies.

To understand national debates and priorities on S&T in China it is important to take three characteristics of S&T management into consideration. This is "shaped by developmentalism, scientism and top-down management" (Zhao & Liao 2016: 2). In the context of developmentalism the idea of S&T policy serving economic development is often stressed since economic growth is the prime goal as described above. A Chinese study on the public perception of Science from 2010 shows that "89% of the Chinese agreed that Science and Technology will make our lives healthier and more comfortable"[15] (Zhao & Liao 2016: 3). This strong belief in S&T or scientism can be found among the

[15] Compared to the European public in 2010, where only 66% agreed with this statement (European Commission 2010: 32).

public as well as the government and coincides with the idea of S&T bringing economic and also social development. Also connected is the top-down management system of policy making in China. Here, the government plays the main role in making decisions and policies, resulting in a comparatively weak market or public. Therefore, public participation in S&T decisions is still rare. Yet, "the rapid social transition in China has led to a series of changes in the attitudes towards and behaviour related to responsibility of innovation of various stakeholders, including public, scientific community, enterprises and government" (Zhao & Liao 2016: 4). There are still strong 'traditional' discourses and structures that continue to shape S&T policy making in China, yet it also appears there is an opening-up and an awareness that changes towards more institutionalized forms of advice (e.g. TA).

2.3 Examples of Values in S&T Priorities

A current example of a S&T priority (and the surrounding policy setting) is artificial intelligence (AI). The development of this field corresponds with Chinese priorities on the advancement of S&T and taking on a leading role in this, also as an element of economic growth. On July 8th, 2017, Chinese government published "The development plan for new generation of artificial intelligence".[16] In this plan, different priorities[17] have been proposed, which can be connected to main values discussed above. A first aspect of this plan is the advancement and excellence of S&T also in regard to international competition. The plan states that it aims to "systematically improve the capability of

[16] http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm#

[17] These include: constructing open and cooperative artificial intelligence technology innovation system; fostering high-end and efficient smart economy; building a safe and convenient smart society; strengthening military and civilian integration in the field of artificial intelligence; building ubiquitous security and efficient intelligent infrastructure system; prospecting the layout of a new generation of artificial intelligence major science and technology projects.

continuous innovation so as to ensure that the level of Chinese artificial intelligence science and technology ranks among the highest in the world". This emphasis on technology advancement represents the value of progress, also through the construction of an infrastructure for research. Progress here is seen as being part of the best worldwide regarding the level of research. In this sense, it also means progressing to be a leader in this area and setting the tone. This of course can also be related to affluence and prosperity, since only through advancement and being internationally competitive can China gain from its developments in artificial intelligence. This also shows in another priority of the plan: "Artificial intelligence has become the new engine of economic development. Artificial intelligence, as the core driver of a new round of industrial transformation, will further release the tremendous energy accumulated by scientific and technological revolutions and industrial changes and create new and powerful engines to reconstruct all aspects of economic activities". Again, affluence and economic development are a main focus here as well as a main justification for developing this technology further.

Next to these somewhat unsurprising priorities for the advancement of AI for China such as growth, leadership in this area and using this technology to create new economic possibilities, the plan also takes up societal aspects. This can be regarded as a novel aspect, since it is possibly the first time a national S&T plan has taken this up. In the plan "double attributes" are presented, which means "high integration of AI's technical and social attributes". In this case, the plan emphasis: "It is necessary to intensify the research and development and application of artificial intelligence, to maximize the potential of artificial intelligence, to predict the challenges of artificial intelligence, to coordinate industrial policies, to innovate policies and social policies, to achieve coordination between incentive development and reasonable regulation, and to guard against risks to the maximum". This reflects the value of peace and safety since it emphasises the need for such a technology to be assessed also according to societal or ethical aspects. The plan takes up the creation of safe and regulated forms of AI, also considering possible effects, and developing

polices accordingly shows that the values of peace and safety have an important role here.

Of course, as this example shows, the development of S&T (such as AI) also means that values may contend one another and that they are not clearly differentiated. How they relate to each other, for example if progress may affect peace and safety, remains open. This also points to the needs for TA, in the sense of providing options and balancing them. This plan shows that issues of societal implications of S&T are relevant and on the radar of policy makers, yet it seems unclear how these will be further debated, balanced or even resolved.

3 TA State-of-Art: Methodologies and Impact

Even though the term Technology Assessment is largely unknown in China, there are still various activities taking place that can be regarded as TA. Against the background of developmentalism or a strong top down structure, TA is bound to be conducted in different ways than in other countries, where different characteristics dominate. Since TA as such is not established in China, looking at key institutions in the Chinese S&T setting can help identify TA-like undertakings and functions as well as the actors involved.

3.1 TA as Policy Advice

A main function of TA is to provide policy advice regarding interests of the public as well as political decisions. A main institution and actor with this function is CAS, which has been key to China's S&T planning. Next to other roles, CAS can be understood as a think tank delivering S&T advice. In 1956, the central government asked CAS to oversee the preparation of the country's first 12-year national programme for S&T development, which fostered

China's drive for modernization of S&T. Since then, CAS has participated in the preparation of all national S&T development plans, serving as a key national think tank. Its proposals have resulted in the launch of a number of key national scientific programmes including the "863 Program" in 1986, which has pushed China's overall high-tech development and the "973 Program", or National Basic Research Program, in 1997, which called for the development of S&T in various fields. Its goal was to align basic scientific research and innovation with national priorities in economic and social development[18].

An important example of TA activity was the Wenchuan rapid assessment survey by CASTED, which conducted a wide field survey on the people affected after an earthquake in the Wenchuan County in 2008. Needs assessments by direct participation of the local people were done and the findings were taken into account for the reconstruction plans. A foresight project on high-tech industries in China aimed at examining different fields of technology, which are of importance to social and economic development in China. Socioeconomic needs were analysed, surveys on stakeholder opinions were undertaken and a comprehensive investigation on the benefits and problems was conducted. This wide consultation and the focus on societal needs were unique parts of the foresight project, which helped identify national priorities and crucial developments (Zhu 2009: 79–84). CASTED has conducted large-scale research and assessment on technology policies in the 1980s, covering 12 national key fields, participated in making the national S&T development plan from the 7th to the 11th Five-Year Plan period and played an important role in the strategic research for the Outline of the National Program for Long- and Medium-Term Science and Technology Development (2006-2020). Also, CASTED participated in assessments and studies on a series of key projects, including economic evaluation and social issues investigation on the Three Gorges Project, studying the technological and economic issues of the Beijing-Shanghai High Speed Railway Project, social and economic impacts of the west line of South-to-North Water Diversion Project and the development of the Large Aircraft

[18] http://english.cas.cn/about_us/introduction/201501/t20150114_135284.shtml

Project. Further, CASTED focused on promoting social development through S&T by conducting exploratory research on S&T risks and social governance. CASTED was also tasked with conducting comprehensive research on the S&T management mechanism reform, which included the reform of research institutes, the transformation of technological achievements, increasing collaboration among industries, universities and research institutes as well as S&T assessment and awarding systems.

Overall, TA as policy advice in China, as the activities by CASTED show, has to be considered in the wider context of S&T. As described above economic growth and prosperity continue to be defining aspects of S&T and their assessment in China. This shows challenges of TA in China understood as policy advice. Government leaders seem to be mainly concerned with S&T advancement and the economic potential of new technologies. As these are the main addressees of policy advice this reflects in the way assessments are done and what they focus on. Currently the main focus of TA in China in this context is therefore on the economic aspects of S&T. Social impacts and possible risks of new technologies have not been sufficiently considered. Further, the lack of institutions and systems that can ensure TA activities and research are even done also poses a challenge for TA as policy advice in the Chinese context.

3.2 TA in Public Debate

The top down structure of decision making in China gives the main role in decision-making to the government. Over the last years it has significantly changed and also improved the lives of millions of people, mainly by lifting them out of poverty, yet it also seems to be increasingly faced with questions from the public as well conflicts regarding issues like well-being or air quality (Zhang & Barr 2013: 134). This also points to the growing importance of forms of engagement in China, also regarding S&T developments, which shows a main function of TA in public debate. Participatory TA aims to involve a larger spectrum of society and with this, making decisions more robust as well as

legitimate. In the Chinese structure, which is very much dominated by top down and developmentalism, a certain degree of public inclusion becomes necessary and as it seems will also eventually be demanded. This presents a unique setting for participatory TA between restricted structures and tendencies towards opening dialogue with wider society. Since S&T developments have the potential to create issues, which concern a wider public, TA has a specific role here.

Movements towards more public communication and participation in China can be seen in the role of non-governmental organizations (NGOs), for example in the context of environmental issues (Zhang & Barr 2013). In the Chinese context, NGOs present actors that can disseminate ideas, provide empirical evidence as well as support the "creative search for alternative solutions. [They] have served to empower the general public and restrain government authority" (Zhang & Barr 2013: 133). It seems that the Chinese government will have to adapt to a growing civil society and empowered citizens, with various actors stepping into decision making processes. Especially pressing environmental issues such as air pollution provide a ground on which a growing awareness of the public is especially apparent in China. Here the effects of demands for economic growth and S&T developments as well as their societal implications become obvious. A gradually pluralized political setting will continue to emerge, creating challenges for the government and its decision and policy making structures. The idea of "authoritarian deliberation" as described by (He & Warren 2011), focusing on China, brings together the apparent paradox of authoritarian rule and deliberation. They connect cultural specifics in China to the top down structures resulting in deliberation or engagement actually making authoritarian rule more resilient and adaptive.

Participation in the Chinese context can mainly be understood as communication (or science popularization), with some areas that are highly disputed and pressing (such as environmental aspects or GMOs). In this setting, it remains unclear whether participation could actually challenge or alter (established) practices of S&T decision making or if it will be increasingly used to stabilize a top down structure. Further, TA's role here remains unclear: How

can inclusion of a wider level of stakeholders within the policy setting be enabled? Especially in the Chinese context, there are tensions and pressures that can make for interesting spaces of engagement. Here, TA with its wide experiences in ethical reflections and how to include this into policy can offer useful ways forward.

Perhaps the most important example of an engagement event to mention in the context of participatory TA in China is a consensus conference in Beijing on genetically modified food conducted in 2008 by researchers from CAS. Here, interested citizens as well as scientists working in the field gathered for discussions on the technical aspects as well as the societal implications of this complex S&T issue. Important was that the CAS researchers were trusted by both sides and therefore could facilitate. Yet, it remained difficult because the participants weren't familiar with the method of consensus conference and therefore not accustomed to taking part in discussions with one another. This event remained the only one of its kind.

3.3 TA in the Engineering Process

TA as part of the engineering process is not known as such in China. Socio-economic or environmental risks assessments are conducted, as in arguably any country today dealing with S&T developments. Yet, in the context of TA there are no clear standards or methods for this as part of an assessment within the development process. Of course, we do find similar problems, reactions or issues regarding S&T developments and therefore require some form of assessment as part of the engineering process. This is especially apparent in the context of large-scale infrastructure project, which can lead to debates or even protest of effected parties. This should be further examined in the Chinese context, also as a way forward regarding useful forms of TA in engineering processes.

As mentioned, this area of TA is difficult to locate in the Chinese context. As mentioned, TA isn't a common term in the country and often activities can merely be related to TA. Regarding TA in the engineering process Health TA (HTA) can be mentioned. HTA was introduced into China end of 1990s. The National Health and Family Planning Commission gradually realised the importance of HTA and since 2000 it has been included in each year's key points of health work. Main institutes working in this area are the Ministry of Health (MOH), The Shanghai Clinical Research Center (SCRC), China National Health Development Research Center (CNHDRC), or The Zhejiang University Biomedical Engineering technology assessment centre.

The other area need to be mentioned is Environmental Impact Assessment (EAI). In 2002, the state enacted the Environmental Impact Assessment Law and in 2016 this law has been revised.[19] EAI in this law means to assess possible environmental impact of plans and construction projects. In Article 5, it says "Government encourages related institutions, experts and public engaging environmental impact assessment in appropriate ways." In the Ministry of environment protection (MOEP) there is a department of environmental impact assessment which is in charge of regulating, management, organizing and implementing EIA.[20]

Besides, there are 51 standards and technical guidelines regarding EIA from the year of 1993 to 2017. For example, Technical guideline for environmental impact assessment (HJ/T 2.1-93); Technical guideline for environmental impact assessment (HJ 2.1-2011); Technical guideline for environmental impact assessment of construction Project-General Programme (HJ 2.1-2016); Technical Guidelines for Plan Environmental Impact Assessment General principles (HJ/T 130-2003, HJ 130-2014). [21]

[19] http://www.zhb.gov.cn/gzfw_13107/zcfg/fl/201609/t20160927_364752.shtml
[20] http://hps.mep.gov.cn/
[21] http://kjs.mep.gov.cn/hjbhbz/ (in Chinese)

3.4 TA Roles Matrix

In China, the impact of TA is mainly in the area of raising knowledge, especially regarding scientific assessment (e.g. monitoring of S&T developments) and policy analysis (e.g. assessment of innovation policies). This results from the top down structure as well as the strong emphasis on development of S&T, in which TA's role is often to support these efforts. Even though there are activities in the area of agenda setting and stimulating public debate (e.g. CAS consensus conference) this role for TA is still rare in China. This is also the case for mediation and re-structuring of public debate as overall the role of forming attitudes and opinions isn't a priority for TA activities in China. As for initialising actions, TA does reframe the debate by providing input for policies (by institutes such as CASTED, IPM or NAIS) and possibly new orientation or emphasis. Yet, introducing new decision-making processes or actual decisions that are taken is not a role that TA in China currently has. As mentioned, this doesn't necessarily correspond with the overall structure in the Chinese S&T system.

From these current roles of TA activities in China come future needs. Regarding TA's role as providing policy advice, it will remain to be seen how the main addressee of these assessments will enable the inclusion of wider issues. As mentioned, a challenge is the focus on economic development and potential of S&T from the government side. Societal aspects seem to be gaining importance, but in the setting of developmentalism and a top down structure this may not often be a priority. Further, there is a certain degree of opening up towards the inclusion of public opinions into the decision and policy making process. This creates a certain tension between a top down organisation and growing demands for inclusions (e.g. regarding environmental issues). This can lead to an authoritarian deliberation, which actually reinforces the top down structure. Here TA would embark on a new role, in which, for example, it introduces new forms of engagement or helps intensify public debate but not, as in European TA understandings, as a democratic pluralistic force. This creates an especially interesting setting for (future) TA in China,

since it remains to be seen what TA's actual role will be when certain debates open up to a wider audience. Future desirable roles for TA would then be to mediate, "build bridges", enhance social awareness and consensus especially regarding the challenges of including more societal actors in S&T decision-making.

Chinese values such as progress and affluence also shape the roles of S&T (as bringing economic prosperity and development) as well as those of TA. Harmony as a key element also means that TA should see its role in shaping ways to mediate between different stakeholders in the Chinese context. The strong emphasis on developmentalism and scientism means that TA could ideally develop alternatives to provide options for decisions, even within top down structures. Further, as described going beyond communication as the main way of interacting with a wider public could also expand how S&T are embedded in society and shaped according to needs and expectations.

4 Chinese Perspectives for Global TA

In recent years, China proposed working to build a community of shared future for mankind, which means a world with lasting peace, common security, common prosperity, open and inclusive, clean and beautiful. For this, China implemented the Belt and Road Initiative with the aim of establishing cooperation with other countries.[22] This coincides with the concept of "community of human destinies" meaning that the major challenges facing the world nowadays are not the ones that a single country can handle alone. Therefore, common, global approaches are required. Under the guidance of this concept, China will continue to promote economic and technological cooperation with all other countries in the world and establish a global governance system. Global assessment and governance of S&T is an important aspect of this

[22] http://www.xinhuanet.com/english/2017-01/19/c_135994707.htm

system. For example, the National Natural Science Foundation of China specifically funds international projects. This is a main activity and includes collaborations like the Sino-German Center for Research Promotion, which is jointly funded by NSFC and German Research Foundation (DFG). It aims to support cooperation and exchanges between researchers and is focused on various areas such as new materials, information science and communication technology, Nano-technology, energy research, environmental research, life sciences, advanced manufacture technology or transportation studies. Of course, any of these areas would also require TA research and in several there is extensive European and German experience in assessing S&T according to societal issues (e.g. energy, Nano-technology, transportation). Here there could therefore be a Sino-German platform oriented along the areas mentioned, which enables TA research as well as exchange of experiences. This shows a need from the Chinese side to include TA in the existing S&T collaborations.

As with any country, China has specific political, cultural and historical characteristics, which shape its internal structure as well as S&T priorities. As described above, these are often focused on further (economic) development of S&T. With a status as a developing country this isn't very surprising. The argument is that a certain level of development has to be reached before possible issues of undesirable outcomes can be contemplated. This is for example the case in the United Nations Framework Convention on Climate Change in which China is regarded as a developing country. As China soars to the second largest economy in the world and has made tremendous achievements in economic and technological fields in recent years, it has also placed more and more emphasis on the coordination and sustainability of development. China's national leaders put forward "Clear waters and green mountains are as good as mountains of gold and silver."[23] In this sense, China is pursuing green and low-carbon development and works to implement the Paris Agreement.

[23] http://www.xinhuanet.com/english/2017-01/19/c_135994707.htm

These developments would also have implications for any TA activities on a global frame, with both “first world countries” as well as “developing” ones. This raises further questions regarding the understanding of the country by itself as well as by others. The status as a developing country comes from the assumption that development (e.g. economic or technical) is a logical next step. Development of food technologies brings security and prosperity to otherwise neglected regions. Yet this can of course be questioned especially regarding issues like sustainability. Further, the strong emphasis on development would surely influence any participation of China in a global TA project, which coincides with the importance of scientism in China as described above. TA as practiced in many European countries questions a technocratic approach to challenges, the technological solution isn’t necessarily without (unintentional) consequences. In this way, TA may question the strong belief that science and technology will offer the best or more robust solution. This could create tensions for a Chinese participation in a global TA project.

China is a socialist country with the aim of achieving common prosperity of all the people, which was a challenge for a long time. And as a big country, China is facing and trying to solve the problem of uncoordinated development in different regions. The experience of balancing excellent and coordinated development of regions at different levels, could help the deliberation between developed and developing countries in a global TA project. Because neglecting the differences in economic strength, the levels of development and the interest demands in different regions and countries will make it difficult to achieve substantive results in international cooperation. Overall for a global level, all possible compromises must be made on the premise of guaranteeing the independence and peace of the country, on the premise of safeguarding the core interests of the country. The territorial integrity, political consolidation and international competitiveness of a country are the basic guarantee for a country's sustained and steady development and the core interests of the country.

These national characteristics also give areas of compromise or non-compromise for Chinese participation in a global TA project. In China, there is a certain degree of "opening up" S&T decision-making debates to a wider public. This comes from various developments and poses a new situation for policy-makers. Here, there could be compromises regarded the possibility of new ways of including, for example citizens. There is a growing awareness among the public, but also the government that inclusion or deliberation is necessary. Yet, this may differ substantially from deliberation or engagement in a European context. Even though there are many unanswered questions regarding the integration of deliberation into different forms of government, there is a certain basic assumption (even an ideal) of engagement (as conducted e.g. in Europe) that is grounded on the idea of transparency and democratic debate. As mentioned this may be difficult to realise in the Chinese context, which can offer transparency to a certain degree (as any other country), but may have issues with ideals of democratic deliberation or debate. In China there is a "shift towards a more inclusive perspective is likely to be driven by pragmatic concerns over (material) well-being of the public, and is a response to destabilizing problems caused by science and technology" (Wong 2016: 160). In this sense, the main motivation for engagement would be to collect the public's opinions on decisions that have already been made. There is awareness of the importance of actually engaging the public within a general lack of a culture of engagement and lay ethics in China. This shows the tensions in a system, which is still overall top down, but where more and more actors (e.g. experts in S&T policy advice, citizens, scientists as well as decision makers) are realising the importance of finding ways to open up these decision processes as least to a certain degree. This of course presents a challenge for TA, which is grounded on ideas of actual engagement and has historically emerged in Western democracies (Grunwald 2018).

This situation in China can be described as follows: "governance-level participation is developing in the absence of regime-level democratisation, combined with a high degree of experimentalism with consultation, deliberation,

and limited forms of democracy" (He & Warren 2011: 271). In this understanding deliberation or engagement is done for functional reasons as a way to respond to growing pressures due to complex situations with many actors and ambivalent outcomes. More and more "the government will need to adapt to an expanding civil society – one that plays a greater role in the bargaining processes so typical of Chinese policy making [...] the government is learning to stomach an increasingly pluralised political sphere" (Zhang & Barr 2013: 135–136). In the light of this, the government may rely on deliberation or engagement in anticipation of possible demands for empowerment and as such creates a connection between its authoritarian structure and deliberation. Features of deliberation that are rooted in Chinese culture are for example responsiveness and attentiveness and there are examples of deliberation activities such as public hearings or elections. Yet the overall result is authoritarian deliberation as the outcomes remain within the context of government approved agendas and control (He & Warren: 2011). This then changes the assumption of engagement or TA being directly connected to democratic (Western) structures and only possible within these. This assumption could hinder global developments towards more responsible developments of S&T as it wouldn't allow for an alternative normative basis (Wong 2016: 155). Therefore, TA should explore how it can be adapted in a context such as the Chinese one, also as a way to reflect on normative foundations and underlying values and how these can provide a basis for TA approaches.

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