Towards the Development of an Approach to Technology Needs Assessment for Adaptation to Climate Change in the Caribbean

ISSUES PAPER

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Prepared by
Kishan Kumarsingh

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1.0 Background and Objectives

1.1 Technology Transfer Framework under the UNFCCC

The achievement of the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) would require technological innovation and the transfer of technologies, including know-how, for mitigation (reducing greenhouse gas emissions) as well as adaptation (reducing vulnerability). This is critical if sustainable development at a global level is to be achieved. Technological innovation, transfer and use must therefore support sustainable development.

In addition to Article 4.5 of the Convention, which deals specifically with technology transfer, Article 4.7 also alludes to the dependence of developing countries on developed countries for financial support and technology transfer to enable them to effectively implement their obligations under the Convention. Decision 4/CP.7 adopted a framework for meaningful and effective actions to enhance the implementation of Article 4.5 as well as established an Expert Group on Technology Transfer (EGTT). Technology transfer has been defined as the flow of experience, know-how and equipment between and within countries[1].

The framework for technology transfer consists of five components: technology needs assessment, technology information, enabling environments, capacity building and mechanisms for technology transfer. Technology needs assessment is therefore a component of an integrated set of activities that are designed to enhance technology transfer, and which is critical to the avoidance of adopting mal-suited technologies that could run counter to sustainable development objectives.

1.2 Technology Needs Assessment Methodology

As part of the work of the EGTT, the UNDP has developed a draft methodology for technology needs assessments (hereafter referred to as TNA handbook), which deals only with this aspect of technology transfer. The handbook acknowledges that there is no "one size fits all" in respect of TNA methodologies, as country circumstances may differ and what may be applicable in one set of circumstances would be totally inappropriate in another. It is intended that the methodology be flexible enough to be adapted as far as is practicable, to suit varying circumstances as it is based on considerations that are fairly generic and common to all. The TNA handbook focuses on mitigation technology, largely because such technology has been fairly well developed over the past years, and there are several examples of application of such technologies. Adaptation issues, particularly in respect of technological needs, are still to be identified and tested. In this regard, this aspect of the TNA handbook can be improved.

[1] IPCC 2000. Methodological and Technological Issues in Technology Transfer. Special Report of IPCC Working Group III. Cambridge University Press

1.3 Objectives of the issues paper

This issues paper is intended to:

1. Highlight key issues relating to technology needs assessment and climate change adaptation in Caribbean SIDs and low lying developing States
2. Enable workshop participants to provide inputs and make recommendations toward the development of an addendum to the existing TNA handbook so that guidance on technology needs assessment for adaptation can be adequately addressed.

This paper should be read in conjunction with the TNA handbook. A series of questions are raised throughout the paper to help workshop participants prepare for discussions in small working groups sessions at the workshop (please refer to the workshop agenda). *It is important to note that this paper is not intended to be prescriptive but rather to provoke discussion and provide some guidelines along which the TNA handbook can be improved to address adaptation concerns.*

2.0 Overview of main vulnerability concerns and priorities in the context of adaptation needs and technology transfer in Caribbean SIDs and low lying developing States

According to the Third Assessment Report[2] (TAR) of the Intergovernmental Panel on Climate Change (IPCC), the globally averaged surface air temperature is projected to warm by 1.4 to 5.8^0C by 2100 relative to 1990, and globally averaged sea level is projected to rise by 0.09 to 0.88m by 2100. Both natural and human systems are vulnerable to the impacts of climate change and some will be irreversibly damaged. Adaptation measures will be required to temper the impacts of climate change although it is recognized that adaptation would not prevent climate change impacts and will incur costs. The extent to which systems can adapt to such impacts depends on their adaptive capacity, which is defined by the IPCC[3] as "*the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences"*. Human and natural systems will to some degree adapt autonomously, although planned adaptation can supplement this. It is therefore implicit that the efficacy of adaptation measures would depend on such factors as wealth, education, human capacity and skills, technology and technological capacity, infrastructure, access to resources and management skills.

The Small Island Developing States (SIDs) and low lying States of the Caribbean region, like other SIDs of the world, are characterized by unique circumstances that pose serious challenges to their sustainable development. Among these are: their relatively small size, remoteness, limited natural resources, human capacity and resources, and technological capability, heavy dependence on imports and fragile eco systems.

These unique features have exposed the region to varying types of vulnerabilities including those to the vagaries of international trade, exogenous economic and financial shocks, and natural disasters as most of the Caribbean SIDs and low lying developing States lie in the path of hurricanes and extreme weather events of the North Atlantic. Such vulnerability has rendered developmental objectives, such as eradication of poverty, extremely difficult if not elusive.

[2] IPCC 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Among the major concerns of the region is the threat posed by global climate change and sea level rise, which would severely affect key socio-economic sectors.

2.1 Mitigation vs. Adaptation

Notwithstanding that Caribbean countries are very minuscule emitters of greenhouse gases, and there remains a need to mitigate increasing GHG emissions, they are quite vulnerable to the adverse impacts of global climate change. Already lacking the adaptive capacity, Caribbean countries have placed priority in adaptation measures to cope with these impacts. However, there are major constraints in instituting adaptation measures. Firstly, the identification of the vulnerabilities of climate change and the inherent uncertainty as a result of the need for comprehensive, scientific assessments and secondly, the identification of adaptation measures, options and technologies based on identified vulnerabilities. There is therefore an apparent dichotomy in vulnerability assessment with inherent uncertainties and the urgent need for adaptation against this background.

Mitigation technologies are fairly straightforward in that they all have a common objective viz, the reduction or avoidance of GHG emissions, and such technologies tend to target specific, well-known emission sectors. Further, there are several case studies[3,4] of mitigation technology applications from which lessons can be learned and taken into account when considering the application of such technology in any given scenario. Adaptation technology poses a more complex scenario given the cross-sectoral and socio-economic implications, and there are limited examples from which there are lessons to be learnt. There is further complication in the case of SIDs because in addition to cross-sectoral issues, there is the issue of scale.

For Caribbean countries to adequately address adaptation issues, comprehensive adaptation needs, particularly in terms of technology and technology transfer would have to be assessed. Technology factors critically in the determination of the real costs of economic and social development and environmental effects and therefore a necessary part of developmental planning, but more so when considering climate change mitigation and adaptation.

2.2 Main Vulnerability Concerns and Priorities in the Context of Adaptation Needs

A review of First National Communications[5] submitted by Caribbean countries as well as climate change issues papers and climate change policies prepared under the regional project Caribbean: Planning for the Adaptation to Global Climate Change (CPACC)[6] was undertaken to assess the concerns of countries in respect of climate change vulnerability as well as adaptation issues. It is important to note that the vulnerability and adaptation concerns stated in these reports were not the beneficiaries of any comprehensive, scientific assessment as a result of the lack of relevant capacity as well as the unavailability of global circulation models that were resolved to the scale of those of the Caribbean region to fully assess vulnerability and inform adaptation options. Accordingly, the vulnerability and adaptation statements found in the reports were largely based on expert judgment.

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[3] IEA 2001. Technology without borders. Case Studies of Successful Technology Transfer. Paris, France. OCED/IEA.
[4] IPCC 2000. Methodological and Technological Issues in Technology Transfer. Special Report of IPCC Working Group III. Cambridge University Press.
[5] www.unfccc.int
[6] www.cpacc.org. See also annex I

Vulnerable Sectors

- *Water Resources*

The vulnerability of water resources is a major concern. Most countries depend on coastal aquifers for extraction and some are already water scarce and have to depend on water importation and desalination to meet water demands. Increased evapo-transpiration as a result of increased temperatures along with sea level rise and salt-water intrusion into aquifers make climate change impacts significant on water resources. Freshwater resources are already under stress as a result of pollution from land-based activities such as agriculture and industry. Other sectors may also be indirectly impacted such as human health, tourism, agriculture and electricity generation from hydroelectric plants.

- *Agriculture*

Agricultural production and exports represent a significant foreign exchange earner for several Caribbean countries. The increase in temperature along with its dependence on water resources identifies the agricultural sector as being at significant risk from climate change. Apart from mainstay agricultural production, subsistence agriculture is a common activity on which a significant percentage of the rural population in most countries depends. Additionally, the majority of socio-economic activity including agriculture occurs in coastal areas of Caribbean countries and agricultural production would also be at risk from salt-water inundation and salinization of productive soils as a result of sea level rise. This is also true of the effect storm surges arising from extreme weather events such as storms and hurricanes. Countries also identified projected increases in agricultural pests and loss of topsoil due to floods and erosion.

- *Human health*

The main concerns regarding the vulnerability of human health to climate change impacts centered on the projected increase in vector borne diseases and heat stress associated with an increase in temperature. In addition, concerns were raised about indirect impacts arising out of other sectoral impacts upon which health issues are related. Accordingly, impacts on water resources, water borne diseases from flooding, and food production and nutrition were cited as probable indirect impacts on human health. Physical structural damage to health facilities arising out of effects of extreme weather events were also raised as possible human health impacts.

- *Coastal and Marine resources and ecosystems/fisheries*

Many Caribbean territories, particularly those in the northern part of the island chain boast diverse coastal resources that includes coral reefs, mangrove swamps, sea grass beds and sandy beaches. These natural coastal features provide physical protection of the coastline form erosion and wave energy through its dampening effect (coral reefs, mangrove swamps and sandy beaches) and also aid in land building (mangrove swamps). Mangrove swamps provide habitat nurseries for coastal fisheries resources. Increases in sea surface temperatures can cause coral bleaching and so expose coasts to increased wave induced erosion. Loss of sandy beaches may have implications for global turtle biodiversity, as Caribbean beaches are important nesting grounds for endangered species. Additionally, these losses can have indirect impacts on coastal fisheries and tourism. Coastal natural resources are already at risk from land-based sources of pollution (and in some instances sand mining of beaches), which can be exacerbated by increased land run off during flooding events as a result of climate change.

- *Infrastructure and Human Settlements*

A significant percentage of economic activity in almost all of the Caribbean territories are located in the coastal zone and coastal plains, which means that there is infrastructure ranging from telecommunications, road transport links, human settlements and airports as well as tourism infrastructure such as hotels and resorts. These are at direct risk from increased extreme weather activity, sea level rise and storm surges. Additionally, flooding and inundation pose threats to livelihoods and socio-economic activity.

- *Tourism*

The tourism industry is a significant contributor to GDP in several Caribbean territories. Each country has its own unique features that would attract tourists ranging from sandy beaches in the more northerly islands to eco-attractions in the southern territories. The point to note is that the attractions are mainly based on the natural resources of these countries. Climate change impacts on other sectors will have indirect impacts on the amenities that make up the tourism package.

- *Forestry/biodiversity*

Forests and water resources are intricately linked. Therefore anticipated impacts on forests as a result of temperature changes can have impacts on watershed structure and catchment characteristics and indirectly on water resources. Additionally, biodiversity is a function of climate characteristic and changes in climate would have impacts on biodiversity. This may have significant indirect consequences on other sectors such as eco-tourism and food production.

3.0 Overview of the draft TNA Handbook and Possible Implications for its Implementation in Caribbean SIDs and Low-lying Developing States

The Handbook provides a description of steps to be undertaken that can help to ensure that TNA is conducted effectively and efficiently. Three types of activity are required:

- Institutional arrangement and stakeholder engagement
- Descriptions of TNA processes and activities
- Implementation actions

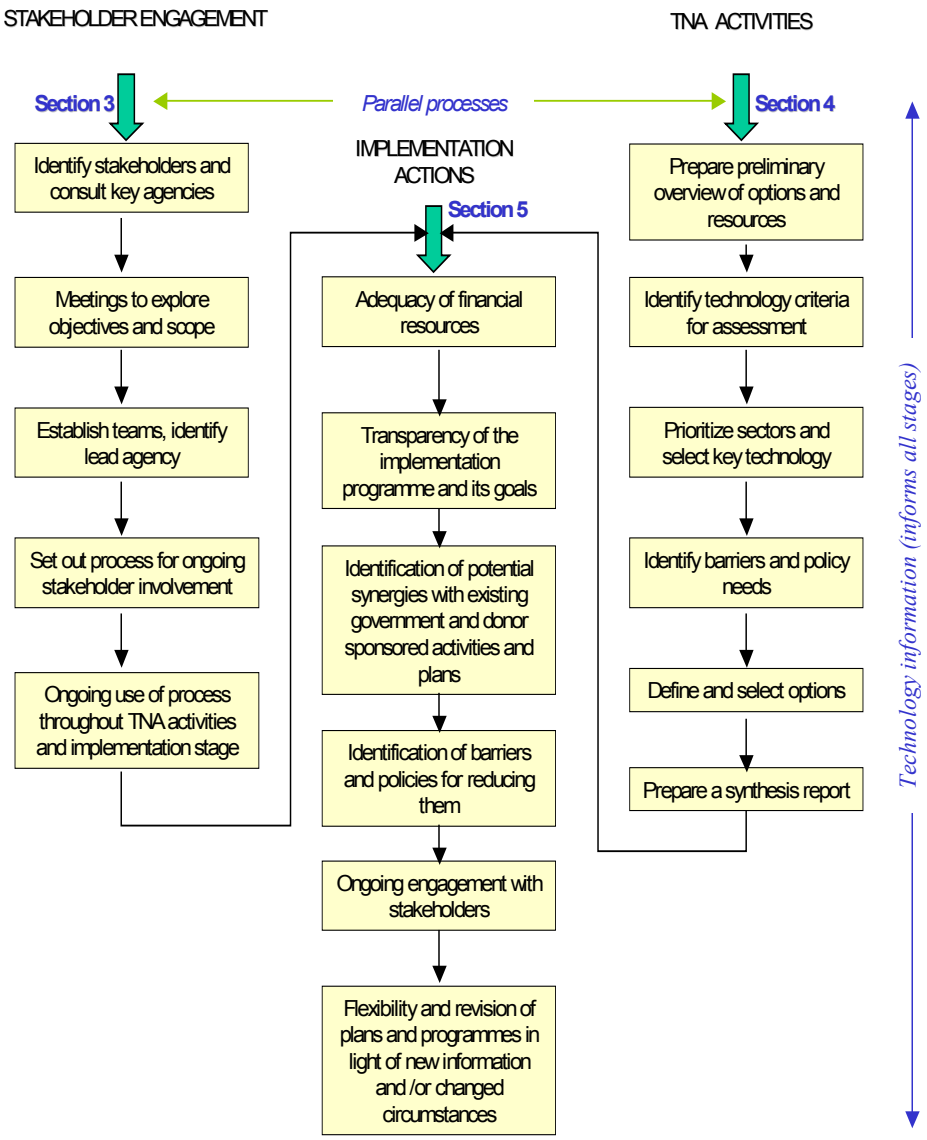
An over view of the processes involved in each type of activity is given in Figure 1.0.

It should be noted that the draft TNA methodology has not been tested in Caribbean countries and therefore it is difficult to assess its efficacy at this stage. Notwithstanding, the methodology contains defined, though generic, steps that are necessary in making assessments of this type, such as stakeholder involvement, assembling expert teams.

The implications for Caribbean SIDs and low lying developing States in using this approach may lie in implementing some of the steps such as describing the selection of key technologies, not only because of the unique circumstances (see introduction), sectoral overlaps and scale, but also largely because the primary concern of such states is that of adaptation. In this regard, the TNA methodology has a heavy leaning toward mitigation technology assessment, which may or may not be applicable in assessing technology needs to address adaptation. While technologies to mitigate greenhouse gas emissions abound, it may be difficult, if not impossible to pointedly identify any particular technology with an "adaptation" label (except perhaps for coastal engineering technologies), mainly because adaptation is sector-specific and adaptation measures implemented in one sector may have indirect adverse effects on other sector which they affect or are affected by. A prime example is the case of "the coastal zone" in small island and low-lying developing states in which a significant amount of socio-economic activity takes place in a relatively high-density scenario (see above). Nonetheless, there may be environmentally sound

technologies that function as, or can function as, an adaptation technology per se, while there may be established mitigation technologies that can also function as adaptation technologies. This section will examine each step in the TNA activities and discuss relevant issues and actions as it may apply to adaptation in a SIDs/low-lying State scenario.

Figure 1.0: Overview of the types of activity involved in TNA[7]



[7] Adapted from the UNDP/GEF Handbook on Methodologies for Technology Needs Assessments. Draft. August 2003.

Stakeholder Engagement

The TNA handbook stresses the importance of stakeholder consultations in the TNA process and would not be repeated here. What needs to be recognized and borne in mind in the stakeholder engagement process from an adaptation perspective, is that affected stakeholders (those in identified vulnerable sectors) would be more widespread and less focused than in mitigation issues, where the emission sectors are concentrated and more defined. For SIDs, this may very well apply to the majority of the population. In this respect, engaging relevant stakeholders may prove to be challenging.

Questions for consideration:

1. Is the approach outlined in the TNA handbook adequate to engage the necessary stakeholders in TNA for adaptation?
2. What additional guidance, if any, should be provided?

TNA Activities

Step: Prepare a preliminary overview of options and resources

Identification of adaptation measures cannot be done in a vacuum, and must be informed by vulnerability assessments. A useful first step in this respect would therefore be an exhaustive sector vulnerability assessment utilizing the available knowledge and involve/include a consideration of the following:

- Extent of sector specific vulnerabilities;
- Cross-cutting issues and indirect impacts on other sectors including socio-economic implications;
- Adaptive capacity of vulnerable sectors in terms of ability to withstand projected climate change effects. For example:
    - Landward migration of mangrove systems in response to sea level rise in the context of changes in the physical environment due to natural (erosion/accretion) and human development (built development);
    - Relocation of human settlements;

Conducting this step can take into consideration the guidelines outlined in the TNA handbook as far as they may apply. On completion of this exercise, it would then be possible to compile a list of options.

Questions for consideration:

1. Should this additional step be considered in the development of an adaptation addendum to the TNA Handbook?
2. If so, what issues should be addressed in developing such a step?

Step: Identify technology criteria for assessment

The identification of technology criteria for assessment may be a premature step in the present TNA sequence. It would be difficult to set technology criteria without an understanding or assessment of the possible response (adaptation) measures that can be applied to a particular sector (as well as its implications for other indirectly affected sectors). Accordingly, this step may be preceded by a consideration of practical adaptation options that can address the particular vulnerability (discussed above). In considering options the following issues may be taken into consideration:

- What actions are required to reduce or eliminate the particular vulnerability?
- Do the identified actions/options adequately address the vulnerability in practical terms?
- What are alternative options/actions to achieve the same result?
- Are there technology implications in the identified options/actions?

The above should culminate in a prioritized list of response measures based on adequate stakeholder consultation. Once this exercise is completed, it would then be possible to set technology criteria.

Questions for consideration:
1. Should the adaptation addendum consider this additional step (e.g. provide guidance on assessment of the possible response measures)? 2. If so, what kind of issues should be addressed to help countries develop a set of criteria against which sectors/technologies are to be assessed?

Step: Prioritize sectors and select key technologies
Based on the above discussion, this step would precede setting the technology criteria. It would be logical to first prioritize sectors that require adaptation action, followed by setting technology criteria, and then the identification of applicable technologies. It is at this stage that an analysis of resources (human and technical) would be undertaken with a view to identifying gaps and needs.

A main consideration in the technology selection (assessment) process is that of capacity building and the requisite "soft technologies" that may apply to a particular technology such as the training requirements, maintenance requirements, expertise, and general sustainability issues (a sort of "user's manual"). While capacity building is required across the board in coping with climate change (such as policy, legislation, institutional, enabling environments etc. and is also a component of the framework for technology transfer), capacity building as it relates to technology needs assessment may be quite specific and is a crucial determinant for successful technology transfer[8] and is especially applicable to the already capacity-strained countries of the Caribbean. For example, a particular technology may be identified as plausible in a particular set of circumstances, but the "soft" requirements may be a significant barrier to its implementation. The current draft TNA methodology in its present framework can be improved by further elaborating capacity building as it relates to technology needs assessment. Technology information plays a crucial and integral role in describing a particular technology to its fullest extent, including these "soft" requirements. In addition to this type of information, there would be a need to explore at the local level, the status quo in respect of technological capability.

Questions for consideration:
1. Should the adaptation addendum to the TNA handbook provide guidance on capacity building as it relates to TNA? If so, what issues should be considered in developing such guidance? 2. What issues should the adaptation addendum include in addressing soft technologies?

Another concern regarding the selection of technologies lay in the impacts of introducing such technology, particularly as adaptation options have cross-sectoral implications. So for example, what can be beneficial to one sector can place another indirectly related sector at a disadvantage.

[8] IEA 2001. Technology without borders. Case Studies of Successful Technology Transfer. Paris, France. OCED/IEA.

Environmental technology assessment[9][10] is an important tool that involves multiple stakeholder perspectives, and which can be used by decision makers to look at the environmental and socio-economic impacts of introducing or using a particular technology (Annex IV provides an outline of the steps that are involved in carrying out an environmental technology assessment).

Once this assessment is completed, decisions can be taken to:

- Modify the project to reduce disadvantages or increase benefits;
- Identify control or regulatory needs;
- Conduct research to further define risks more reliably, clarify uncertainties and take corrective measures to reduce or eliminate negative effects;

Thus, environmental technology assessment may be incorporated as a sub-step in the technology selection process. As with the foregoing discussion, application of details outlined in the TNA handbook for selecting technologies can be used as far as they may apply.

Questions for consideration:
1. Are there other tools that may provide additional guidance or assistance in assessing technology options that should be considered? For instance the environmental technology assessment (see Annex IV)

Step: Identify barriers and policy needs

The identification of barriers and policy needs is an important step in assessing applicable technologies. In the context of adaptation, this step may prove to be challenging. Barrier identification should be integrated in each step of the assessment, as these barriers can take several forms. As adaptation is cross-sectoral, barriers can exist in areas such as policy, trade, legislation, institutional and human and technical capacity, all of which may be applicable to a particular sector. It would therefore be a more feasible approach to examine barrier issues at each step, as barriers in one sector can also serve as a barrier in a related sector. The TNA handbook outlines comprehensive approaches to identification of barriers and can be used where applicable.

Questions for consideration:
1. Does the TNA handbook provide adequate guidance on barriers? If not, what additional issues should be considered in developing the adaptation addendum?

Step: Define and select options and prepare report

These are logical final steps, which are adequately described in the TNA handbook and which can be applied in the adaptation framework.

Questions for considerations:
1. Are there any additional issues that should be considered to better respond to adaptation concerns?

[9] UNEP IE. Anticipating the Environmental Effects of Technology – A Primer and Workbook. 1996.

[10] UNEP IETC. Training Needs in Utilizing Environmental Technology Assessment (EnTA) for Decision-Making. 1995. Technical Publication Series 1

Implementation Actions
The activities outlined in the TNA handbook dealing with implementation actions are generic and can be applied to adaptation technology as well. However, it may be that in that actual application, modifications may have to be made, although it appears that this would not be difficult.

4. Adaptation, Technology and the Long-term Developmental Process in Caribbean SIDs and Low-lying Developing States

SIDs and low-lying States of the Caribbean have already agreed to the implementation of various principles of sustainable development in the Barbados SIDs Programme of Action (BPOA). Climate change has been rated as a priority issue and therefore logically, such issues are expected to be considered in sustainable development planning. Implementing mal-suited adaptation options in the medium to long term may rob other development priorities of much needed and already scarce resources. Such medium to long term implications may therefore need to be considered in any technology needs assessment process in pursuing sustainable development objectives. Issues such as development plans, physical land use planning, population projections, and other sectoral policies and requirements may need to be considered in adaptation planning as well as incorporated in assessing technology needs, and the implication of adopting any related technology. An important issue in this context is the realization that it may be impractical to conduct adaptation technology assessments for anticipated changes that are projected to occur in the very long term, and which also contains a level of uncertainty. Most development plans do not span more than a decade or two. In recognition of the fact that TNA is not a one-off exercise and has to be continuously reassessed as new technologies are developed and uncertainties are reduced, it is important that adaptation TNA be approached from a perspective of sustainable development planning. Indeed it would be impractical to assess applicable technologies for long-term situations. It may therefore be useful in conducting adaptation TNA to consider building resilience into natural and human systems, from a technological perspective, that can function effectively in the long-term.

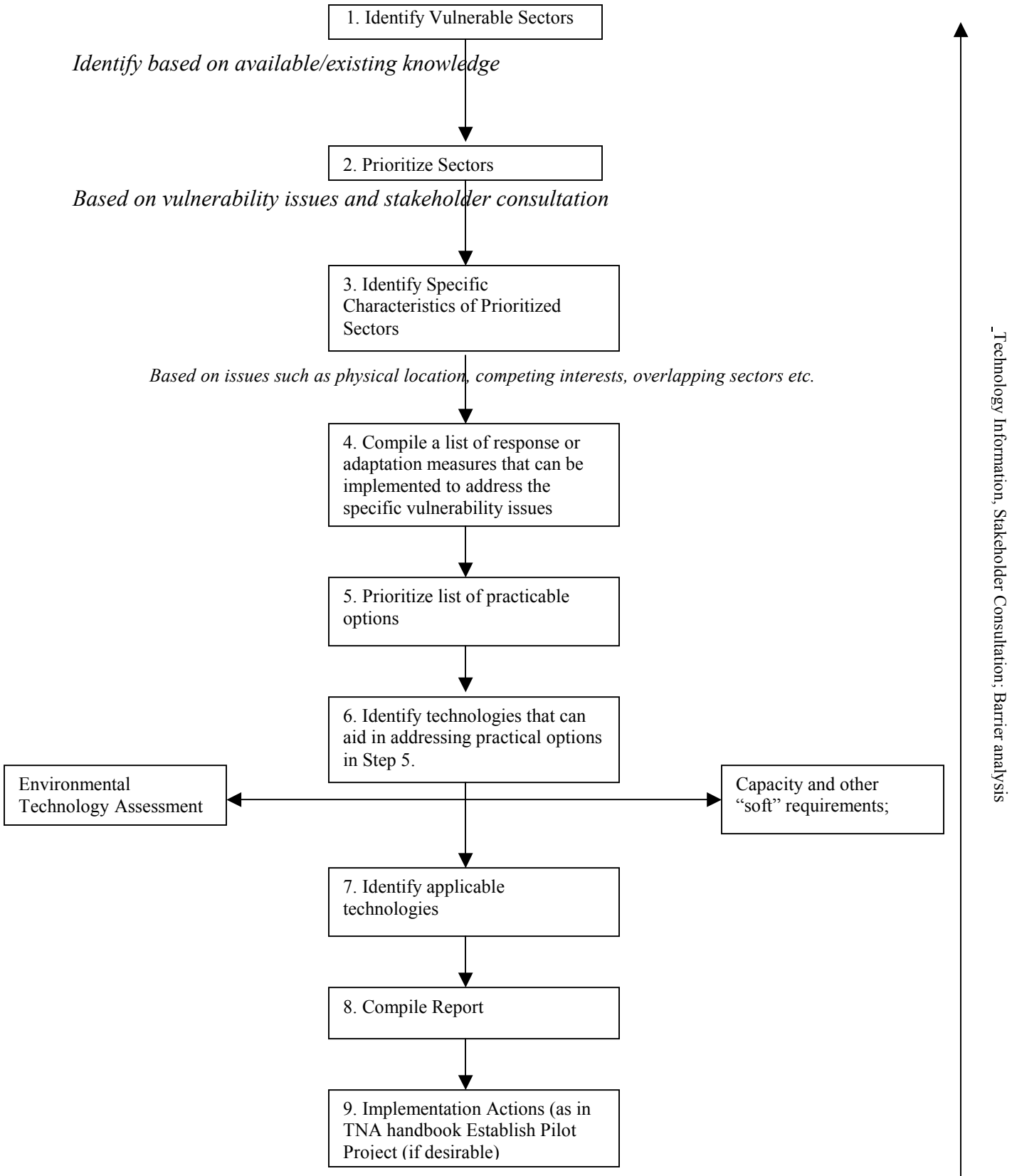
5. Towards a Framework for Adaptation TNA in the Caribbean

Having examined the TNA methodology in the context of its application to Caribbean SIDs and low-lying States, the following presents some guidelines/modifications to the existing TNA handbook towards formulating a framework for adaptation TNA in the Caribbean.

It is clear that the identification of adaptation options is country and sector specific based on the identified vulnerabilities. This reinforces the notion of no "one size fits all" approaches and therefore any TNA methodology would have to be flexible enough to accommodate the differences within the Caribbean States themselves. *The idea here is not to develop a separate framework from the draft TNA but to incorporate the issues raised in this paper in developing a framework that may be more suitable for SIDs and low lying States using the TNA handbook as reference.*

A possible framework for adaptation TNA is outlined in Figure 2.0

Figure 2.0 Draft Framework of Modified TNA Activities as applied to Adaptation



The identification of barriers along with technology information cut across all the steps and should be considered at each step.

This outline should be considered in conjunction with the UNDP TNA methodology with a view to tailor an approach that will suit the needs of the particular country. *It should be noted that this merely represents a possible outline for a framework and can be modified. There may be various sub-steps that would need to be fleshed out.*

Annex III provides an overview of practices that can be applicable as adaptation measures in the region as well as explores sector-specific environmentally sound technologies that may function as adaptation technologies. *It should be borne in mind that this is not intended to be prescriptive but to provide some guidance towards defining adaptation technology and assessing other possibilities.*

6. For further consideration and discussion of workshop participants

The foregoing has attempted to address the main concerns regarding technology needs assessment in the context of the unique circumstances of Caribbean SIDs and low lying developing States, adaptation concerns, the relevance and applicability of the draft TNA methodology, and some guidelines in identifying adaptation technologies as well as some elements for consideration in outlining a frame work for TNA. While there has been a focus on adaptation, consideration should be given as to whether a single TNA process can address both adaptation and mitigation issues.

With this background, and in conjunction with the draft TNA handbook and the set of questions provided under each section above, participants are asked to consider the following for further discussion at the workshop:

- What additional steps may be needed in TNA
- How can these steps be incorporated fleshed out (if at all) in the existing draft TNA methodology and the draft framework outline proposed (figure 2);
- What further guidance can be provided in identifying possible adaptation technologies;
- Ways in which relevant stakeholders (government, private sector, technology professionals, academic and training institutions, NGOs, etc.) can be engaged in the process bearing in mind the nuances of Caribbean societies;
- The extent and possible ways, if at all, to which an assessment of the impacts of environmental technology should be incorporated in TNA.

ANNEX I

Current National and Regional Initiatives Addressing Adaptation to Climate Change in the Caribbean and their Implications for Technology Use and Transfer

The main initiatives at the country level in the last three years would have been implemented through the regional CPACC project, in which all the countries in the Caribbean Community (CARICOM) participated. The project concluded in December 1997 and comprised 9 components. A new project: Mainstreaming Adaptation to Climate Change (MACC) is currently underway and also involves the CARICOOM countries. It is useful to briefly look at the lessons learned in the CPACC[11] project as well as describe the activities to be undertaken in the MACC project and their implications for technology transfer and use. Apart from the regional projects, most countries of the region have accessed the additional funding, often referred to as "top-ups", from the GEF in furtherance of activities started under the preparation of their initial National Communications. Activities under this additional funding can include the conduct of technology needs assessments. Additionally, some countries are involved in conducting National Capacity Self Assessments (NCSA) under the Capacity Development Initiative, which seeks to look at capacity building for the implementation of the UNFCCC, the Convention on Bio Diversity and the UNCCD. The results of such assessments

CPACC

The CPACC project consisted of nine components, of which four were regional and five were executed in individual countries. The nine components were:

Component 1. Design and installation of sea-level monitoring systems

Eighteen automated sea level and climate monitoring stations were installed in the participating countries. Regional climate data can now be integrated into global data sets and a Regional Archiving Centre (RAC) has been established at the University of the West Indies St. Augustine Campus in Trinidad. Necessary personnel were trained to assure data quality and skills to manage, maintain and service the network have been developed at the Caribbean Institute of Meteorology (CIMH) in Barbados and in national meteorological offices.

Lessons learned and Opportunities:
There were limited capabilities at the technical level for the maintenance and operation of these stations. It illustrates a very good example of technology transfer, but regional capacity needs to be built for successful, long-term implementation. The strengthening of regional institutions to provide ongoing training in formal courses (CIMH) is an example of an opportunity in capacity building for technology use. Additionally, technology has improved since the present system was procured. A significant problem continues to be that of "time drift" and results the loss of useful data. There is therefore a wide window of opportunity for technology transfer and use within this component, including both "hard" and "soft" technology issues.

[11] Final Report of the Caribbean Planning for Adaptation to Global Climate Change (CPACC) Project. April 1997-December 2001. Produced jointly by the Unit for Sustainable Development of the Organization of American States and the CPACC Regional Implementation Unit. Washington, D.C.- Barbados, August 2002.

Component 2: Establishment of Databases and Information Systems

This component was essentially an enabling activity and was designed to facilitate access to information for the project stakeholders. Countries were equipped with computers and Internet access and a CPACC website was developed.

Lessons learned and Opportunities:
Information technology is always changing and this component provides an opportunity for developing and incorporating technology information in its network.

Component 3: Inventory of Coastal Resources and Uses

This component developed a Coastal Resources Information System (CRIS) and built capacity to implement such a system in each of the countries. There was a distinct technology transfer process as training was given in data collection and automation, feature extraction for satellite imagery, database design and system maintenance and system use for decision-making.

Lessons learned and Opportunities:
The CRIS system provides useful opportunities for the research and data collection and management that is required for vulnerability assessments and adaptation analysis. However, continuous capacity building and training in emerging technological tools would be required in order to maximize the potential of this system.

Component 4: Formulation of Policy Frameworks for Integrated Adaptation Planning and Management

This component helped to strengthen significantly national capacity to analyse critical issues of climate variability and change. Countries were encouraged to develop short, medium and long-term strategies and approaches to adaptation and are expected to facilitate integrated planning and management for cost-effective response to climate change impacts. Policies were expected to be accepted at cabinet level of national governments as a result of the process involved ion the policy formulation.

Lessons learned and Opportunities:
Limited capacity has been built in assessing various aspects of vulnerability assessments and integration into policy frameworks for response measures. There are opportunities for the incorporation of adaptation response measures in respect of technological approaches in revisions to these policies so that they can be implemented in affected sectors in an integrated manner. However, the capacity to undertake in-depth impact/vulnerability studies, the development and use of down-scaled global climate scenarios and the development of country-specific climate scenarios provide very good examples of opportunities for technology transfer.

Component 5: Coral Reef Monitoring for Climate Change Impacts

Component 5 was a pilot project and involved the strengthening of capacity to monitor coral reefs for climate change impacts through the development of a monitoring methodology and training in its application.

Lessons learned and Opportunities:

Capacity in data processing and management has been developed and a regional node for carrying out data quality assurance and data analysis has been established at the Centre for Marine Science, based at the Mona Campus of the UWI in Jamaica. Further development and refinement of the methodology as well as the development of other monitoring methodologies for other sectors are possible opportunities for technology transfer and use in assessing impacts of climate change in making decisions on adaptation options.

Component 6: Coastal Vulnerability Assessment

This component was one of the pilot components and involved the development of a methodology for conducting coastal vulnerability and risk assessments.

Lessons learned and Opportunities
Capacity for vulnerability assessment is lacking in the region. There is a need to develop credible climate scenarios through statistical downscaling of global models to region-specific climate change projections. The transfer of "soft" technology to address this lacuna would be very useful.

Component 7: Economic Valuation of Coastal and Marine Resources

This component generated a methodology for the valuation of economic resources and was a pilot component. The objective was to help countries to apply the tools of resource valuation, environmental accounting, and environmental decision-making in the development of policy frameworks and economic and regulatory approaches within the context of their coastal and marine resources.

Lessons learned and Opportunities
A key achievement, though in a limited way, has been the enhanced capacity of individuals from various technical fields in economic valuation. There is a need for further training and transfer of soft technology, particularly in the application of relevant software, which must be integrated into the capacity building process. Opportunities are present for the continued training and capacity building. This is especially true for economic valuation of the coastal zone for reasons given above (e.g. localization of socio-economic activities in the coastal zone) particularly as any adaptation planning or implementation would necessarily have to take socio-economic impacts into consideration.

Component 8: Formulation of Economic and Regulatory Proposals

The overall objective of this pilot component was to assess the design and utility of economic and regulatory approaches in coastal and marine resources management in response to sea level rise. The component also sought to examine ways in which economic incentives can be used to provide effective alternates to more traditional, regulatory policies in promoting adaptation to climate change.

Lessons learned and Opportunities
A critical lesson learned was that the design of market-based instruments should be integrated with environmental planning and management. Economic instruments remain relatively weak and ineffective without a sound economic basis, including the assignment of relative economic values to resources. Capacity building towards the development of relevant and adequate economic instruments, given the diversity within the Caribbean countries, remains a challenge and may provide some opportunity for the transfer to "soft" technologies towards adaptation in The Caribbean.

Component 9 involved the preparation of the Initial National Communications of St. Vincent and the Grenadines and for the purposes of this paper would not be discussed here.

MACC

The overall objective of MACC [12]is to facilitate the creation of an enabling environment for climate change adaptation in the small island and coastal developing states of CARICOM. While there is no component or sub-component dealing specifically with technology needs assessment or technology transfer, it is implicit in each of the components and sub-components (both "hard" and "soft") and it is expected that in the implementation of this project, technology requirements and implications will emerge.

The main components and sub-components of this project are:

1 Build capacity to assess vulnerability and risks associated with climate change

- Strengthening the climate impacts monitoring network
- Generating climate change projection scenarios
- Generating climate impact scenarios
- Refining a harmonized methodology for assessing climate change vulnerability and adaptation policy making
- Preparing vulnerability and risk assessment studies in key economic sectors

2 Build capacity to reduce vulnerability to climate change

- Identifying and incorporating "no regrets" adaptation measures
- Developing climate change adaptation approaches for selected sectors and upgrading environmental impact assessments (EIAs)
- Disaster prevention through strengthening technical norms for infrastructure development
- Developing country level multi-sectoral adaptation strategies

3 Build capacity to effectively access and utilize resources to reduce vulnerability to climate change

- Development of a regional agenda for climate change policy within the international framework
- Development of a regional strategy for adaptation to climate change

4 Public Education and Outreach

[12] Project Appraisal Document for the Caribbean Mainstreaming Adaptation to Climate Change Project. World Bank Report No. 25540

ANNEX II

Case Studies of Success Stories in the Caribbean [*]

The following highlights some success stories implemented in the Caribbean that can function as mitigation/adaptation measures.

- Solar water heating in Barbados, St. Lucia addresses energy conservation and emission reduction (mitigation and adaptation);
- Coral transplantation in damaged coral reefs in Barbados represents a good example of building resilience in natural coastal protection systems (adaptation);
- Solid waste management programmes in St. Lucia, Jamaica encourages recycling and less environmental impacts with reduced indirect impacts on human health (mitigation of emissions from land fills and adaptation);
- Wastewater management programmes in Jamaica reduces pollution in coastal areas thereby reducing stress and maintaining resilience of natural systems such as coral reefs. There are also indirect benefits to human health (mitigation for emissions from wastewater and adaptation);
- Forest management in Grenada addresses conservation of watersheds and water resources (adaptation).

There are also desalination plants in Barbados, Antigua and Barbuda, and Trinidad and Tobago, which serve to utilize seawater resources and conserve freshwater supplies for potable consumption.

[*] www.sidsnet.org

Annex III

Overview of Possible Applicable Practices and Environmentally Sound Technologies as Adaptation Measures

This section draws heavily from the possible adaptation interventions described in Section 1.1 above as well as projects that have been implemented in the Caribbean region (Annex II: Case Studies), and which illustrates possible practices that can serve as adaptation measures. Additionally, a brief overview of applicable environmentally sound technologies is given based on the review presented in Section 1.1. *It is intended to provide a guide only and flexibility in its design and application may be necessary to suit individual circumstances. The intention is for participants to consider the extent, if at all, to which environmental technology assessment should be incorporated in TNA*

Policy

There are already current policies and practices that can work towards meeting adaptation needs. For example, some countries are signatories to the Ramsar Convention on wetlands and would have prepared national wetland policies. Accordingly, wetland conservation would necessarily be incorporated in the development process. Additionally, many countries already have environmental legislation or are developing environmental management legislation which can provide for the incorporation of environmental impact assessment (EIAs) for new developments, and which can look at climate change impacts as part of the terms of reference of preparing the EIAs. Although some countries lack environmental management legislation per se, there are many pieces of legislation, such as for planning and development, which can be used to address climate change from a policy and legal perspective. However, in many cases, countries have identified the need for developing policy and legislative frameworks to address climate change. An assessment of relevant policies and action plans may be desirable when exploring suitable avenues for technology implementation as part of the TNA process.

Possible Applicable Technologies

As has been alluded to before, knowledge of adaptation technologies and practices is limited[12]. However, there are available a wide range of sector-specific environmentally sound technologies that can function as adaptation technologies depending on the vulnerability of the particular sector[13]. With this in mind, and considering the vulnerable sectors and interventions detailed in Section 1.1, the following section attempts to provide a list of applicable technologies in particular sectors. ***It should be borne in mind that this is not prescriptive, nor does it attempt to evaluate the merits of any particular technology.*** Application of any technology would require other considerations as involved in the conduct of TNA.

Water Conservation

Countries identified pollution stresses on water resources as a major concern. Pollution from agricultural activities was also cited as a major source of pollution to water resources. Pollution control technology can function as an adaptation and mitigation measure with indirect human health and environmental benefits.

[12] IPCC 2000. Methodological and Technological Issues in Technology Transfer. Special Report of IPCC Working Group III. Cambridge University Press.

[13] Sustainable Business. Economic Development and Environmentally Sound Technologies. The Regency Corporation Limited in association with the United Nations Environment Programme. 1998.

Chemical Pollution from Agriculture

Agricultural activity can affect water quality through run off from fertilizers, pesticides and soils into surface and groundwater. A logical approach would be to prevent/reduce the amount of chemicals used. Two such approaches can be:

- Integrated Pest Management (IPM): - involves pest control methods including growing pest-resistant cultivars, crop rotation and tillage techniques. Efficient and proper application of pesticides can reduce chemical loads.
- Integrated Plant Nutrition Systems (IPNS): - involves the efficient use of nutrient supply to crops; helps to improve productive capacity of soils; timely and sufficient use of on- and off- farm nutrient supply can reduce run-off to surface-, and leaching to, groundwater.

Irrigation

Water demands for irrigation can be significant. Application of simple, low-tech systems can contribute to water conservation[10].

- Low-energy precision application systems which deliver water closer to the ground can be 90 per cent more efficient; large sprinklers can be made more efficient by attaching vertical drop tubes to the sprinkler arm;
- Surge flow irrigation: - the intermittent application of water to furrows or borders;
- Increasing soil moisture in the root zones of crops: - capture of hillside run-off channeled into fields;
- Small scale methods: - small reservoirs to capture and store rainwater, percolation tanks to replenish groundwater, check dams to increase rainwater productivity;
- Treatment of wastewater for irrigation: - a variety of filtration systems can be used to reclaim water for irrigation, thereby returning valuable nutrients to the land and reducing water contamination;

Sanitation

Poor sanitation can be a major cause of surface and groundwater degradation. There are technologies that utilize waterless systems that are applicable to housing developments.

Biotechnology

Biotechnology can potentially be used in addressing many environmental problems. Such application can be done in water treatment, treatment of solid wastes, agriculture (creation of resistant cultivars to adverse weather conditions), and pollution clean-up and combating desertification.

- Wastewater treatment: - biological treatment can cope with a wide range of effluents: nitrates, phosphates, heavy metal ions, organic compounds and toxic substances. Anaerobic systems can also produce useful methane depending on load and type of organic matter and can have indirect application in sanitation and water conservation techniques e.g. bioreactors. Applications can be done for domestic and industrial wastes.
- Bioremediation: - used for the clean-up of polluted sites; application may be site specific.
- Bioreactors: - treatment of landfill sites, agricultural industries to produce methane.
- Biotechnology can also help reverse the impact of desertification and land degradation by increasing water retention and prevention of salt damage (due to sea level rise). Gene recombination and cell fusion techniques can provide longer-term benefit by breeding plants to survive desert conditions and irrigated with seawater.

The main constraint in biotechnology transfer is the lack of technical capacity and resources in developing countries.

Coastal Protection

Coastal engineering structures such as sea walls, groynes and breakwaters are perhaps the easiest identified adaptation technologies. However, sometimes low-cost systems can be employed to serve other beneficial functions as well. A good example is the development of artificial reefs that lend coastal protection as well as provide fish habitat. Another example is artificial sea grass beds that can serve to reduce coastal erosion.

Annex IV

Outline of the Environmental Technology Assessment Approach

The environmental technology assessment can be applied at both the micro and macro levels to make decisions, which are in keeping with a country's policies. While environmental impact assessment is a public policy tool invariably required by regulators, EnTA adopts a comprehensive systems approach that takes a broader look at the effects of technology and considers alternatives. UNEP[11] describes a ten-step approach that can be useful in considering technology needs when integrated in TNA. These steps are:

1. Examine the reason for the proposed technology
   - Understanding the purpose for which a technology is being applied can aid in the consideration and understanding of alternatives.
2. Describe the technology
   - Including a description of material, energy, capital and labor inputs, engineering processes and operations.
3. Alternative analysis
   - Possible modifications that may be required. An understanding of the reason for the technology is critical.
4. Examine the longevity of the technology
   - How would future developments impact on the efficacy of the technology?
5. Stakeholder participation
   - Identification of individuals, institutions and organizations that may be affected by, or can influence, the technology.
6. Evaluate potential impacts
   - Direct impacts of the technology itself e.g. outputs etc.
7. Identify key decision makers
   - Those who have authority to act or influence technology.
8. Identify action options for the framework that supports decision-making
   - Regulations, economic incentives etc.
9. Draw conclusions
10. Make recommendations