Climate-proofing urban infrastructure in developing countries: advantages, challenges, and considerations under uncertainty

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ABSTRACT**:** Cities in developing countries are suffering from growing infrastructure deficits due to rapid urban growth. Infrastructure, with a long service life, needs to take into account future climate change in its design. 'Climate-proofing' refers to the explicit consideration and internalization of climate change to ensure delivery of services made available by the infrastructure at acceptable levels over its service life. While the concept is well recognized, there are still limited cases in developing countries in proposing climate-proofed projects derived through quantitative assessments. Thus, this article first undertakes a comparative review of seven cases in developing countries in Asia ([i] urban floods in Bangkok, Thailand; [ii] urban floods in Ho Chi Minh City, Vietnam; [iii] urban floods in Manila, Philippines; [iv] urban floods and [v] water supply in Khulna, Bangladesh; [vi] inland monsoon floods and [vii] cyclones in Bangladesh) where climate-proofing has been conducted, in order to identify advantages and challenges of climate-proofing. The review reveals advantages of climate-proofing, such as presentation of costs and benefits that will assist decision-making, preliminary designs of infrastructure, and specific recommendations of adaptation options. On the other hand, limitations include: (i) assessments are not made from the viewpoints of equity and legitimacy; (ii) costs and feasibility of supplementary measures (soft options) are usually not analyzed in detail; and (iii) assessments are time- and resource-consuming. Issues of uncertainties, although highlighted in these cases, have not been well incorporated in the analyses. The article thus secondly looks into robustness of adaptation options, by applying the four criteria used in the literature – no regret, reversible and flexible, safety margins, and synergies with other measures. An analysis of the proposed adaptation options in the water supply and urban drainage systems in Khulna, Bangladesh demonstrates that the consolidated options as a whole meet the criteria and are considered robust to uncertainty, while each option does not necessarily meet all the criteria. The assessment also identifies the need to evaluate the effectiveness of each option, but further research is warranted to analyze distributional effects of adaptation options, and institutional arrangements for implementation.

KEYWORDS: adaptation, climate-proofing, robustness

1. INTRODUCTION

Cities in developing countries are suffering from growing infrastructure deficits due to rapid urban growth. Climate change imposes another challenge, as the infrastructure may not be able to provide its intended services over its service life due to future climate change. For example, development of a new source of water supply may not be suitable after 10 years due to saline water intrusion in the water source. This requires 'climate-proofing' of the project, which refers to the explicit consideration and internalization of climate change to ensure delivery of services made available by the infrastructure at acceptable levels over its service life. Climate-proofing infrastructure is part and parcel of the mainstreaming process (UNDP 2011), or one stage (project stage) of mainstreaming (Sveiven 2010). While the concept of climate-proofing is well recognized, there are still limited cases particularly in developing countries in applying this concept through quantitative assessments to propose adaptation measures.

1.1 Objectives

The paper has two objectives. First, it identifies advantages and challenges of climate-proofing by undertaking a comparative review of seven cases in developing countries in Asia where climate-proofing has been conducted. Second, the paper specifically looks into robustness of proposed adaptation options under uncertainty, by applying the criteria used in the literature. This highlights a need to formulate a set of measures to effectively respond to future uncertainties. The paper also discusses two main approaches for climate-proofing, as each approach requires caution in deriving appropriate adaptation options.

2. METHODOLOGY

The paper is developed based on the literature review, except for two cases in Khulna, where the author was directly involved in the analysis. A number of literature, both peer-reviewed journals and gray literature, were reviewed to triangulate the information provided in key documents, which was also supplemented by a few interviews with city officials and experts concerned.

3. COMPARATIVE REVIEW

3.1 Cases selected

There are still a very limited number of quantitative climate impact assessments in developing countries, including in Asia, as reviewed by Hunt and Watkiss (2011). Moreover, the vast majority of research studies stop at impact assessment (Wilby and Dessai 2010), and do not provide specific adaptation options. Through a careful literature search, seven climate-proofing studies in developing Asia have been found and are reviewed in this study. They are summarized in Table 1.

Table 1 Case studies reviewed

Location	Climate risks studied	Sources
Bangkok	Urban flooding	Panya Consultants (2009); ADB et al (2010)
Ho Chi Minh City	Urban flooding	ADB (2010a); ADB et al (2010)
Manila	Urban flooding	Muto et al (2010); ADB et al (2010)
Khulna	Urban flooding	ADB (2010b, 2011a)
Khulna	Water supply	ADB (2010b, 2011a)
Bangladesh	Inland monsoon floods	World Bank (2010a, 2011)
Bangladesh	Cyclones	World Bank (2010b, 2011)

ADB = Asian Development Bank.

Climate projections and impact assessments were made for 2050 in these studies, except for Khulna where assessments were made for both 2030 and 2050.

3.2 Findings

3.2.1 Identified costs and benefits

Among the seven studies reviewed, five studies monetized the costs of damages, while values vary widely among the climate scenarios chosen and locations. Even in two studies where damage costs were not monetized, the magnitude of impacts were shown quantitatively, in terms of the number of days in a year when river salinity is higher than standard in case of the water supply in Khulna, and the increase in inundation area and population exposed to inundation for inland monsoon floods in Bangladesh. Quantitative data on the potential damage of the impacts caused by climate change provide decision-makers in developing countries with the clear magnitude of problems of climate change in a form easy to understand.

Furthermore, all seven cases made at least a preliminary cost estimate of key adaptation measures, i.e., infrastructure improvement. Three out of seven (Bangkok, Manila, and urban flooding in Khulna) also estimated the benefits of adaptation measures in the form of reduction in damage and loss from flooding, thereby enabling a cost-benefit analysis (CBA). In all three cases, adaptation investments are proven to be economically feasible, although the analysis should be regarded as indicative only. A least-cost analysis was conducted for water supply in Khulna. Quantitative recommendations for infrastructure improvement, such as the size of the impounding reservoir for Khulna's water supply or increase in pumping capacities in Bangkok, are provided. A breakdown of costs corresponding to the scope of infrastructure investment (such as heightening of the embankment, widening of drains) is available in most cases. Economic impact estimates allow for a better understanding of the human activities affected by climate change and serve as a basis for dialogue, understanding, and decision-making to limit the cost of climate change (Hallegatte et al 2011).

3.2.2 Adaptation options

Similarities are observed among the studies in the adaptation options proposed, because the risks studied are increased flooding and inundation except for the water supply in Khulna. Embankment of rivers, improvement of drains, and increase in pumping capacity are key engineering options, while non-engineering (soft) options such as land-use controls and early warning systems are also recommended. In the water supply system in Khulna, relocating the water intake upstream or installing a larger reservoir[1] are proposed as core adaptation options. Further engineering designs at the next stage will take account of the quantitative impacts of climate change on the proposed infrastructure, and consider the specific scope of work of soft measures. In all cases, recommendations did not merely stop at designs of infrastructure, but covered wide range of soft measures such as policy, regulatory, and behavioral issues to ensure long-term delivery of services.

3.3 Discussion

These pilot cases demonstrate that climate-proofing is possible through a quantitative analysis (scenarios-impacts-first approach, discussed later), and quantitative information derived in the analysis would be useful for decision-makers as well as designers of infrastructure. Following the findings and recommendations of climate-proofing work, improvement of the urban drainage systems in Bangkok and Khulna, water supply systems improvement in Khulna, and polder improvement in coastal areas of Bangladesh, have moved to or will move to the specific engineering design stage, at least partially.

Adger et al. (2005) proposed elements of effectiveness, efficiency, equity, and legitimacy in judging successful adaptation. Among the four elements, the above-analysis generally addresses

[1] The reservoir is for storing river water when the water is not saline and using it when the river water is too saline.

efficiency and effectiveness. However, the issue of equity, or impacts on the poor, is not analyzed in detail. As the poor usually have less access to risk-reducing housing and infrastructure, they will likely be most severely affected by climate change. The design of infrastructure and other supplementary measures need to take account of distributional effects of costs and benefits. Legitimacy also requires further attention, because the proposed measures need to be widely accepted by stakeholders including the local governments responsible for the implementation of the proposed options.

There are other limitations and challenges in these studies. First, costs of supplementary measures (mostly soft measures) are not estimated. This is probably because of the focus of the studies that assess the design of the infrastructure required to deal with climate change, and lower costs of supplementary measures relative to infrastructure investments. Nevertheless, the total costs of adaptation should be estimated and compared with the total benefits. Second, feasibility of adaptation options, particularly supplementary measures, is not discussed. Land-use planning, early warning systems, and building codes that incorporate climate change vulnerability are standard recommendations for reducing vulnerability from urban floods, but cities in developing countries have not been historically successful in implementing these systems, irrespective of climate change. The third issue is the costs and time required in the assessments. Studies for Khulna, for both water supply and urban flooding, took nearly one and a half year and cost about $500,000. Resources could be justified for large cities with large infrastructure investment requirements, but more simplified and less resource-intensive work may be needed for smaller cities.

Issues of uncertainties are well acknowledged and discussed in all the studies reviewed. What appear to be effective and efficient adaptation options under a specific scenario may or may not be necessarily so among widely different scenarios. There is a risk for an overinvestment or an underinvestment. While these studies rightly caution the limitations of assessment and stress the importance of incorporating soft measures, no specific analyses were undertaken to ensure the robustness of adaptation options. Therefore, the next section assesses the issue of uncertainty.

4. ROBUST ADAPTATION UNDER UNCERTAINTY

The adaptation options proposed for the Khulna study, both for water supply and urban flooding, are analyzed. Major reasons for focusing on Khulna are the availability of background data due to the author’s direct involvement, and its uniqueness to address both water supply and urban flooding. Khulna, the third largest city in Bangladesh with a population of about one million, is located in southwestern Bangladesh, where the consequences of climate change are expected to be particularly severe. As a deltaic plain, the land is flat and the average altitude of the city area (47 km^2) is only about 2.5 meters above the mean sea level (ADB 2011a). Khulna currently relies entirely on groundwater, but the level of water supply services is poor in terms of coverage and service hours (24% and 12 hours per day respectively in 2011; Local Government Division 2013). Thus, it plans to develop a new surface water supply system. Moreover, the city is suffering from chronic waterlogging problems during the rainy season.

4.1 Framework for assessment

In order to address specifically the issue of uncertainty in future climate and its impacts, Hallegatte (2009) proposed a decision-making framework that comprises five practical strategies: (i) 'no-regret' strategies that yield benefits even in the absence of climate change; (ii) 'reversible and flexible' strategies; (iii) 'safety margin' strategies that reduce vulnerability at null or low cost; (iv) 'soft' strategies; and (v) strategies that reduce decision-making time horizons. He added conflicts and synergies of adaptation options as an important consideration to make (also found in Sovacool 2011). These five strategies are often cited in other literature discussing decision-making under uncertainty (e.g. Wilby and Dessai 2010, Smith et al. 2011, Lal et al. 2012). In this evaluation, among the five strategies, the soft strategy is consolidated with the reversible and flexible strategy as these two are quite similar, and the reduced decision-making time horizon is not included due to its limitation in application in infrastructure development. Synergies between options are retained, while interpretation is broadened: i.e., co-benefits with other policy measures such as disaster risk reduction, environmental conservation, and public health improvement, in addition to climate change mitigation. An adaption option can be considered robust if it meets all these four criteria.

4.2 Water supply

Four individual options as well as a consolidated option comprising all the four options are evaluated, and the summary of the evaluation is in Table 2.

Table 2 Evaluation of adaptation options

Option	NR	R/F/S	SM	Sy
Impounding reservoir	Y/N	Y/N	Y	N.A.
Physical loss reduction	Y	Y/N	N.A.	Y
Water demand management	Y	Y	N.A.	Y
Rainwater harvesting	Y	Y	N.A.	Y
Consolidated option	Y	Y	Y	Y

N = no, N.A. = not applicable, NR = no-regret, R/F/S = reversible, flexible, and soft, SM = safety margin, Sy = synergy with others, Y = yes, Y/N = depends on the implementation.

Among the four options, the size of capital investment required is large for impounding reservoir[2] and physical loss reduction, relatively small for rainwater harvesting, and small for demand management. The latter two can be classified as soft measures. The impounding reservoir option may or may not be a no-regret option: although the salinity level of raw water is on an increasing trend and exceeded the national drinking water quality standard in terms of chloride concentration for 15 days for the first time in 2010[3] (ADB 2011a), it is still early to conclude whether a reservoir is a must for the surface water supply system without climate change. The impounding reservoir option has some flexibility, although this is a hard engineering measure. It will be constructed in rural areas near the water intake, so it is possible to take an adaptive management approach, whereby the physical investment is made in a phased manner, depending upon the result of water quality monitoring of the river - the initial size of the impounding reservoir is rather small while securing land for future expansion; the reservoir will be expanded depending on the actual rise of river salinity in the future. An opposite approach may also be possible, whereby a

[2] The government chose the option of a larger impounding reservoir over that of a water intake upstream.

[3] In Bangladesh, maximum allowable chloride concentration for drinking water is 1,000 mg/L in the coastal zone including Khulna, and 600 mg/L in other areas.

safety margin is added to the size of the reservoir so that water that meets the national water quality standards can be supplied even under more extreme conditions.

Physical loss reduction is a no-regret measure. As the current physical loss of water supply is rather high in Khulna, estimated at 36% (ADB 2011b), a successful reduction to 15% will lead to savings in costs of water supply. This option is not reversible, but the extent of reduction can be flexible. Demand management may be able to reduce the demand by 10% (from the designed per capita domestic water demand of 120 liters per day), if water pricing, or charging economic costs of water to consumers, is introduced effectively in addition to awareness-raising. Rainwater harvesting may augment the water supply available by an additional 10% or so. With these three measures combined, an almost 40% reduction in the volume of required raw water may be possible. All these three options have co-benefits in terms of resource conservation.

However, the implementation of these three options cannot negate the need for an impounding reservoir: if the river salinity in terms of chloride concentration exceeds the national standards, an alternate source of water is required. Thus, an impounding reservoir, core adaptation option, will still be necessary. Another important point is that other adaptation options are compatible with and supplementary to this core option, and may provide great potential for cost savings by reducing the required size of the reservoir. The consolidated option can meet all four strategies, as it has no-regret, and flexible and soft components, could apply safety margins, and creates synergies among individual measures. The consolidated option can ensure robustness to different future scenarios, although further analysis is warranted for a best mix of these hard and soft measures, which is beyond the scope of this study. In this particular case, the water utility chose the phased approach over the safety-margin approach with regard to developing an impounding reservoir, as it saves initial investment costs.

4.3 Urban flooding

An assessment was conducted similarly, and the summary is in Table 3.

Table 3 Evaluation of adaptation options

Option	NR	R/F/S	SM	Sy
Drainage system improvement	Y	N	Y	N.A.
Solid waste management	Y	Y	N.A.	Y
Building codes	Y	Y	Y	Y
Land-use planning	Y	Y	Y	Y
Early warning systems	Y	Y	Y	Y
Land subsidence suppression	Y	Y/N	N.A.	Y
Consolidated option	Y	Y	Y	Y

N = no, N.A. = not applicable, NR = no-regret, R/F/S = reversible, flexible, and soft, SM = safety margin, Sy = synergy with others, Y = yes, Y/N = depends on the implementation.

Drainage system improvement including improvement of drains, river dredging, and sluice gate improvement, is a core adaptation option without which the problem of urban floods cannot be sufficiently addressed. Including this, all the given options are no-regret measures, as Khulna is already suffering from chronic water-logging, and all these measures, though to a different extent, would contribute to alleviate the problem. One difference with the water supply is that the core option is not very flexible - widening or constructing new drains in a phased manner in dense urban areas is not a practical option. Therefore, it will be sensible to implement the core option early with some safety margins incorporating future climate change, and ensure effectiveness through implementing and strengthening other adaptation options which are more flexible. All non-core adaptation options are compatible with the core option. Enforcement of building codes and land-use planning and controls is needed to avoid mal-adaptation: strengthened protection through infrastructure improvement should not foster new settlements into areas prone to urban floods. These measures can be implemented with a safety margin, and have co-benefits in terms of disaster risk reduction. Solid waste management is also important to ensure functionality of drains and bring public health benefits. This also has potential for climate change mitigation through a reduction in the generation of methane gas. An early warning system is another soft measure used to mitigate impacts of urban flooding, and can incorporate a safety margin in the warning system. Land subsidence, currently estimated at about 10 mm per year in Khulna (ADB 2011a), is a threat to urban floods, and reduction in the rate of subsidence is another soft option.

As in the case of water supply, a consolidated option can meet all four strategies. Thus as a whole, these options are considered robust to future climate change and variability.

In discussing adaptation measures to flood risks in Mumbai, India, Hallegatte et al (2010) proposed different strategies to cope with different risk layers: improved drainage system for frequent low-impact events; zoning and land-use plans for rarer events that cannot be avoided through improved drainage; and early warning, evacuation, and insurance for exceptional floods that cannot be avoided with improved drainage or zoning. It is important to analyze the nature and scope of each option, and formulate a set of actions that are mutually reinforcing.

Lastly, it is interesting to note that a reduction in the volume of abstraction of groundwater, which will be made possible with the introduction of the surface water supply systems (and to a lesser extent by introduction of rainwater harvesting leading to groundwater recharge), may slow down the pace of subsidence, although the cause of subsidence is not well studied. There is compatibility between the improvement of water supply systems and that of urban drainage systems.

4.4 Discussion

The above assessments made clear that the effectiveness of an adaptation measure needs to be placed at the center of the analysis, if the objective is to adapt to climate change. No matter how efficient in implementing soft measures, an impounding reservoir will still be necessary for the water supply in Khulna. Otherwise a very different option, such as increased abstraction of groundwater instead of surface water, or accepting saline water exceeding the standard when necessary will need to be adopted. Another important consideration is compatibility among the proposed adaptation options: some may create synergies, while others may create conflicts. For example, an increased use of groundwater resources to cope with high river salinity, if selected as an adaptation option, may lead to further land subsidence and have negative consequences for the urban drainage system. Compatibility is linked to co-benefits (or co-costs), which is also synonymous with no-regret, as no-regret implies there are other benefits even without climate change. Desalination, while it was not recommended for the water supply in Khulna due to the lack of financial viability, would lead to higher energy consumption and greenhouse gas emissions; so this is not compatible with other objectives.

4.5 Need for further research

As climate-proofing of infrastructure usually provides adaptation options to be implemented by government agencies, further research is warranted to integrate this initiative with bottom-up local adaptation measures taken by communities and households. This is particularly important for developing countries where the capacity of government agencies is normally limited. Berrang-Ford et al (2011) find that most adaptations in low-income countries are reactive, occurring at the individual and community level with weak involvement of government stakeholders, while adaptations are more proactive or anticipatory, and likely to include governmental participation in high-income countries. The analysis should address the institutional capacity of responsible government agencies, and arrangements to be made between those agencies and households or communities. Moreover, distributional effects of adaptation measures, including who benefits and who loses, cannot be overstressed (e.g. Leichenko 2011).

As for the water supply in Khulna, the Khulna Water Supply and Sewerage Authority (KWASA) is responsible for the implementation of climate-proofed surface water supply system development. All the adaptation options discussed earlier are under their jurisdiction. However, the coverage of water supply services is still low, and many of the poor have no access to piped water supply systems. Therefore, unless coverage is substantially increased together with supply augmentation, people without access will continue to rely on other sources of water such as shallow tube-wells, which are reported to be increasingly saline (Roy et al 2012). Roy et al (2012) raised a concern over a ban imposed by KWASA on deep tube well installation as this would further expose poor urban people to scarcity of safe drinking water. Projects need to be inclusive, and reduce the vulnerability of urban poor to impacts of climate change.

Urban drainage system improvement is further complicated. Among the adaptation options analyzed, the Khulna City Corporation (KCC) is responsible for improvement of drains and river dredging, solid waste management, implementation of building codes, and early warning systems, while the Khulna Development Authority (KDA) is responsible for land-use planning. KWASA has a role to play in land subsidence suppression as it has authority to regulate groundwater abstraction. Moreover, among the flood management measures, improvement of river embankment and major hydraulic structures fall under the responsibility of the Bangladesh Water Development Board (BWDB), whereas re-excavation, dredging, and rehabilitation of existing drains and construction of new drains are the responsibility of KCC. Roy et al (2012) cite a coordination issue between KCC and BWDB about the operation of sluice gates, and KDA’s ignorance of urban poor settlements in its urban planning. They also stress unsecure tenure as a key issue for the poor to make investments in their shelter and basic service improvement, thereby making them particularly vulnerable to the impacts of extreme and severe events which would be exacerbated with climate change. Institutional arrangements to foster better collaboration should be further studied in improving urban drainage systems.

5. APPROACH FOR CLIMATE-PROOFING

A major challenge in climate-proofing is to address the issue of large uncertainties involved in the assessment, as it often relies on projections made for a few decades or more distant from now. Climate-proofing through a quantitative assessment generally starts with climate-scenario building and downscaled climate projections, followed by consequent changes (e.g. increased run-off), impact assessment (e.g. level of flooding), valuation of damages (costs), identification of vulnerabilities, and identification of measures to negate or alleviate impacts. This approach, used in all seven cases reviewed in this paper, has been classified as the Predict-Then-Act (or Adapt) or cause-based method (Lempert et al. 2004; Gersonius et al. 2012). Downscaling is becoming more sophisticated and ensemble of models is used instead of only one model to reduce the bias in projection. However, concerns have been expressed for this method due to large uncertainties involved in the projection (e.g. World Bank 2012). Critiques suggest an effect-based approach instead, which starts by specifying an outcome used to define acceptability thresholds to manage the impacts, assesses the likelihood of attaining or exceeding this outcome as a result of changing drivers, and identifies viable adaptation strategies. A number of research articles have been published to demonstrate the effectiveness of this method (e.g. Kwadijk et al. 2011; Gersonius et al. 2012). Lal et al (2012) describe the former as the top-down scenarios-impacts-first approach and the latter as the bottom-up vulnerability-thresholds-first approach, and summarize the strengths of each approach.

The approach chosen would have significant implications for the management of uncertainty, the timing of adaptation options, and the efficiency of policymaking. The scenarios-impacts-first approach is most useful to raise awareness of the problem, to explore possible adaptation strategies and to identify research priorities, when sufficient data and resources are available to produce state-of-the-art climate scenarios at the spatial resolutions relevant for adaptation, and when future climate impacts can be projected reliably (Lal et al 2012). The vulnerability-thresholds-first approach, on the other hand, is particularly useful for identifying priority areas for immediate action, and assessing the effectiveness of specific interventions when planning horizons are short, resources are very limited, or uncertainties about future climate impacts are very large. They further stress that these two approaches are complementary and need to be integrated (also in Mastrandrea et al 2010). A CBA, which is a popular tool for assisting decision-making and recommended when both costs and benefits can be monetized, goes well with the scenarios-impacts-first approach, which is more straightforward and probably easier to understand for many people. In situation with limited uncertainty, the CBA and sensitivity analysis (changing parameters and/or assigning probabilities) can provide very useful information to decision-makers. Under deep uncertainty where different opinions exist about the parameters and probabilities to be used, the CBA should be applied with caution and complemented with open consultations and discussions. It is important to note that future uncertainty should not become a barrier to analyze and implement actions for reducing risks to climate change.

6. CONCLUSION

The advantages of climate-proofing through quantitative climate assessments at a project level have been confirmed. The quantitative assessments provide specific information on the level of damage and required costs of adaptation, and propose specific adaptation options. Most cases reviewed in this article present how much and by when the infrastructure needs to be improved to adapt to climate change, which will facilitate decision-making and provide a basis for further project formulation work. This is especially useful in cities in developing countries, where basic infrastructure is often inadequate, urban population is rapidly growing, and urgent infrastructure improvement is needed (Hallegatte and Corfee-Morlot 2011). A climate-proofed infrastructure is expected to deliver intended benefits and services over its service life despite the changing climate, although the success of climate-proofing on the ground has yet to be observed. There are limitations in these case studies, however, such as lack of attention to equity and legitimacy, and rather perfunctory analysis on the feasibility of soft measures.

Issues on uncertainty cast doubts on the effectiveness and efficiency of adaptation measures proposed through quantitative assessments. Therefore, it is essential to further analyze the nature of each proposed option. The strategies of no-regret, reversible and flexible, safety margins, and synergies among options, are applied to specific adaptation options in the water supply and drainage systems in Khulna, Bangladesh. While each adaptation option does not always meet all four criteria, consolidated measures as a whole meet all the criteria and are evaluated as robust to uncertainty. This underscores the need to review not only each option individually, but compatibility between options. Consolidated measures include core engineering options to ensure effectiveness of adaptation, and other hard and soft measures that are flexible, compatible and mostly no or low regret. Although finding a quantitative best mix of these measures (in terms of cost and output) is not possible in this study, adopting a set of measures ensures robustness to various future scenarios. Further research is warranted to address the issues of equity and legitimacy, and to assess the institutional capacity of relevant government agencies, based on which an appropriate institutional arrangement should be formulated.

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