Sri Lanka
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Chapter 8
Facing Climate Change Threats: The Importance of Better Information

by
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8. Facing Climate Change Threats: The Importance of Better Information

8.1 Introduction

Several thousand small farmers in the dry zone of Sri Lanka faced severe rainfall events with significant livelihood impacts in early 2011 and late 2012. More recently, there was a significant loss of life amongst the fishing community and damage to property in June 2013 as a result of stormy weather conditions. Against normal expectations of local climate conditions, these events undoubtedly took the affected farming and fishing communities by surprise, despite the fact that over the last few decades, such climate-related shocks have become more frequent and intense, impacting the livelihoods of many communities. Such adverse events have called public attention to the need for timely and reliable information on weather and climate. While various measures have been proposed to face such situations, their success depends largely on the availability of reliable climate information. Several studies and pilot projects undertaken in Sub-Saharan Africa and other developing countries, have underscored the importance of Climate Information Products (CIPs), such as seasonal forecasts as decision-support tools, to face rising incidents of climate shocks.

> ***"Bridging the information gap on climate shocks can be considered as a priority issue in facing the threat of climate change"***

The threat of climate change, which is fast becoming a reality in day-to-day economic life, is increasingly becoming a key factor in emerging challenges that a developing country such as Sri Lanka faces. Adverse climatic events are a significant social and economic burden on a country. They are likely to be even more so when such events are precipitated as unanticipated shocks to an economy, with resultant disruptions and set-backs to growth and development targets. Whilst climatic related shocks cannot be subject to any degree of certainty, attention to developing tools and mechanism to be better informed of such impending threats is clearly the way forward.

The threat of climate change is a phenomenon that ought to be dealt with through scientific knowledge – i.e., essentially by an information driven process. In this context, a gap in information is a major constraint that needs to be addressed in all aspects of meeting this global challenge. The effective use of appropriate climate information products has a major role to play here.

Climate is inherently variable across temporal and spatial dimensions. It has never been a matter of certainty, and coping with climatic 'variability' has remained an eternal challenge faced by humanity. Rapid, broad sweeping 'change' of climate, due to anthropogenic causes has the potential to compound this situation further. There are two major strategies involved in facing the threat of climate change – mitigation and adaptation. Mitigation aims to reduce the level of greenhouse gas (GHG) emissions through cooperative actions. Adaptation constitutes actions that are taken to moderate, cope with, or take advantage of actual or expected change of climate and related shocks. It is a dynamic process of adjustment that involves decisions under risk and uncertainty.

The topic of climate information is examined here mainly from the perspective of adaptation decisions. For Sri Lanka, being a small island nation in the tropics with a high level of vulnerability to harmful impacts of climate change, it is logical to assert that the country's national climate change strategy should focus more on adaptation than mitigation.[1] As far as information on climate risks is concerned, countries like Sri Lanka are always at a disadvantage. The resolution of global circulation models (GCM) is still not sufficient to cover the details on small countries with complex topography, compared with larger geographic units. With limited scientific capacity to develop locally applied models or to downscale local effects from the global models, information on climate uncertainty is a major obstacle to be faced in making effective decisions on adaptation at all levels. Despite limitations in information availability, action against the rising threat of climate shocks cannot be delayed anymore. Therefore, bridging the information gap on climate shocks can be considered a priority issue in facing the threat of climate change. The primary purpose of this Chapter, therefore, is to examine the current situation with regards to climate information in Sri Lanka, and the measures that can be taken to bridge the existing information gap as the country strives to achieve its long term growth and development objectives.

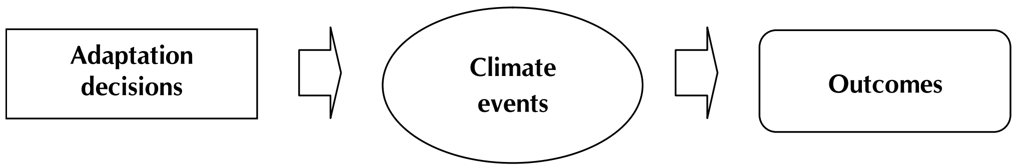
8.2 Climate Information Products: An Economic Commodity

Information is an economic commodity with scarce supply relative to demand. Climate information is not an exception to this. There are a variety of CIPs that cater to demand originating from a wide range of users. In this section, a broad review on CIPs is presented from the perspective of an economic commodity. It begins with an account of the nature of CIPs with relation to their role in adaptation as decision-support tools.

Climatic variability and change are sources of uncertainty that can lead to climatic events with unanticipated outcomes. Hence, adaptation decisions are necessarily risky choices. The choice is among options that can either moderate losses, or take advantage of the impacts of climatic events in different domains of human activity (e.g., agriculture, coastal fisheries, and disaster prevention). At any given point of time, deci-

[1] Sri Lanka's contribution to global GHG emissions is relatively low compared with industrial nations or emerging economic powers. Therefore, mitigation efforts have a limited role to play.

Figure 8.1
Nature of Adaptation Choices



sion-makers face the choice among options that could lead to different outcomes under many probable climatic events. Hence, adaptation decisions are made with imperfect information, and decision-makers have to arrive at expectations regarding the likely climatic events (e.g., rainfall expectations) when they make choices. The CIPs have an important role to play here by helping to reduce the uncertainty associated with adaptation decisions made by various stakeholders, that range from high level policy decision-makers to grass root level actors such farmers and fishermen. The essential nature of risky decisions of adaptation is shown in Figure 8.1.

There is a time gap between actual decisions and outcomes of decisions during which they are subject to uncertain climatic events. The CIPs have the potential to make positive contributions to decision outcomes by:

- Forewarning and helping to prepare for adverse events
- Enabling the potential to take advantage of favourable conditions

This can help to generate economic value by minimizing the losses due to climate shocks, and/or by generating value addition by making use of favourable climate events. This way, CIPs can make a positive economic contribution by lowering uncertainty in decision-making, if they are correctly formulated, assessed, communicated, understood, and successfully integrated into the decision-making process.

8.2.1 Nature of Climate Information Products

Climate information could range from advanced information products generated with the help of sophisticated forecast models, to laymen's oral interactions about local weather conditions based on personal experience. From an economic perspective, what is important is the decision-support role of information contained in a given information product. In this connection, forecast products that make predictions about future climate events are the most important form of climate information. As a result, climate forecasts and projections have attracted the most attention of climate change researchers. Hence, climate information can broadly be categorized as:

- Climate forecasts and projections
- Other CIPs.

Other CIPs may include information products such as classifications of agro-climatic zones, cropping calendars, sowing/planting windows etc., that provide useful information for planning and management of activities. Such products are usually based on the analysis of long term weather data on selected climatic parameters.

Climate Forecasts and Projections

Climate forecasts and projections provide useful decision-support information, and therefore play an indispensable role in modern economies faced with rising incidents of climate shocks. The purpose of climate forecasts and projections is the prediction of the future state of climatic parameters. They predict future climatic conditions with specified periods of lead time — usually probabilistic predications about selected parameters such as precipitation, temperature, or wind. They could be available in categorical or continuous probability forecast formats. As information products, climate forecasts usually have characteristics of public goods: non-divisible, non-excludable, and non-rival in consumption.

While both forecasts and projections provide predictions about future climate conditions, they have certain technical differences also. Forecasts attempt to generate a picture about the actual future evolution of climate parameters over a specific time scale such as daily, weekly, monthly, seasonal, annual, or supra-annual scales, with a certain level of confidence. The future time scale covered by a forecast is the lead time of a forecast. Typically, the level of confidence attached to predictions tends to decrease with the length of lead time. They are based on models which are abstract mathematical representations of the climate systems at varying levels of complexity. The most comprehensive models of the climate system are known as Atmosphere-Ocean General Circulation Models (AOGCMs).

One of the most widely studied forms of forecasts is Seasonal Precipitation Forecasts (SPF). They are also known as seasonal rainfall outlooks. The SPFs are designed to predict seasonal variations of rainfall with lead times, usually in the range of 1-6 months. They are based on computer models on atmospheric-oceanic circulation patterns that try to exploit ocean-atmospheric interdependencies, to predict the likely future events of rainfall. They particularly try to exploit anomalies caused by climatic phenomena such as El-Nino Southern Oscillation (ENSO), to recognized circulation patterns to make predictions about likely events of climate. The Madden-Julian Oscillation (MJO) and the Indian Ocean Dipole (IOD) are two other sources of anomalies that are being used for the prediction of climate in the tropics.

Projections also try to compute potential future evolution of climatic variables, but their predictions are subject to an identified set of assumptions about future conditions known as scenarios. Scenarios are based on assumptions about the future developments of technological/socio-economic conditions that could positively or negatively influence the levels of GHG emissions and atmospheric concentrations.[2] Such projections may provide vital information necessary for policy making. For instance, current concerns in climate change in small island nations such as the Maldives have largely originated from projections about the future sea level rise, under certain scenarios of GHG emissions. As in the case of climate forecasts, climate projections are also based on simulation models, and they usually try to cover longer term horizons (e.g., target projection years such as 2025, 2050, and 2100). The confidence levels attached to projections are described using a scale of likelihood connected to corresponding ranges of probabilities. Table 8.1 presents a scale of likelihood used by the Inter-Governmental Panel on Climate Change (IPCC) in global climate projections.

Disregarding the type of CIP, a major challenge faced in climate predictions is forecast uncertainty, referring mainly to variability of observations. The variability of climate observations could originate due to

[2] For instance, the IPCC uses a standard set of scenarios known as Special Report Emission Scenarios (SRES) in climate projections.

Table 8.1
A Scale of Likelihood Used to Assess the Uncertainty of Projections

Terminology	Likelihood of the Occurrence/Outcome
Virtually certain	>99% probability of occurrence
Very likely	>90% probability
Likely	>66% probability
More likely than not	>50% probability
About as likely as not	33 to 66% probability
Unlikely	<33% probability
Very unlikely	<10% probability
Exceptionally unlikely	<1% probability

natural causes, as well anthropogenic processes such as global warming. With greater uncertainty, the more difficult it is to forecast, which lowers predictability as a result. In forecast modelling, researchers attempt to exploit sources of predictability associated with non-stationary patterns of climatic parameters, such as tropical atmospheric circulation and recognized patterns of anomalies (e.g., ENSO, MJO, and IOD).

8.2.2 Supply and Demand for Climate Information Products

As in the case of many economic commodities, value chains can be identified for CIPs based on supply and demand relations. The value chains of CIPs involve a range of stakeholders that include providers and users of information products. From the supply side, forecast providers represent the point of origin of CIPs in the value chain. There are global, regional, and national level providers of CIPs. Given the public good nature of CIPs, many providers are usually state, inter-governmental or non-profit agencies. At the national level, major providers of CIPs are national meteorological services (NMS) such as Meteorological Departments or Weather Bureaus (e.g., Department of Meteorology in Sri Lanka). Given the limited technical capacity of the NMS in developing countries, they usually have to depend on global and regional level information providers for the technical preparation of national and sub-national level CIPs. Such agencies include inter-governmental bodies [(e.g., IPCC, and World Meteorological Organization (WMO)], or technical agencies sponsored by developed nations. A few examples of such agencies are, the Commonwealth Scientific and Industrial Research Organization (CSIRO), National Centres for Environmental Prediction (NCEP) in the US, the Japan Meteorological Agency (JMA) and the International Research Institute for Climate and Society (IRI). Agencies and professionals involved in the provision of CIPs are sometimes known as the 'climate prediction community' (CPC). The CPC includes researchers on climate systems and forecast modelling, operational forecast providers, forecast application experts, and other academic/technical persons involved in different aspects of climate prediction. Members of the CPC from different countries share the know-how in forums, such as Regional Climate Outlook Forums (RCOF).

The demand for CIPs comes from users who are decision-makers at different levels. A range of users could be identified from grass root levels (e.g., rain-fed farmers, fishers,

Table 8.2
Adaptation Decisions and Types of Matching CIPs

Time Horizon of Decisions	Types of Adaptation Decisions	Types of Matching CIPs
Short term	Tactical	Daily, weekly, monthly forecasts.
Medium term	Strategic	Multi-year or multi-seasonal predictions
Long term	Structural	Long term climate/ impact projections

etc.) to national, regional, and global policy decision-makers (e.g., climate change policies, disaster management policies, irrigation/agriculture/fisheries management policies, etc.). A few broad categories of decisions taken by those user groups can be identified as:

- Long term structural adaptation decisions
- Medium term strategic adaptation decisions
- Short term tactical adaptation decisions

Outcomes of decisions that extend over decades or more are those related to structural adaptations. Decisions that involve time horizons from one to a few years can be called as strategic adaptation responses. Decisions concerned with short term intervals — seasonal or annual — are the tactical responses. This classification is based on time horizons usually attributed to human decision-making, rather than time horizons associated with impacts of climate change.

Different user categories typically need knowledge on the likely impacts of future climate events over short, medium, and long term horizons, when making decisions on adaptation, and their information needs may vary depending on the type of decisions they make. On the other hand, CIPs vary in terms of lead time of predictions. A crude matching of type of CIPS with different time horizons of adaptation decisions is given in Table 8.2.

8.2.3 Factors Determining Demand for Climate Information Products

The bottom line for demand of CIPs is that they should be able to improve the outcomes of decisions taken with the aid of forecasts, compared to outcomes of decisions taken without forecast information. This is the prime source of value of CIPs. However, the context of CIPs is relatively complex than many other economic commodities. As a result, the demand for CIPs could be affected by product-related characteristics, as well as a number of extraneous factors. Among the product related characteristics, quality and value of products are the most important.

Quality of CIPs

Both quality and value of forecast products have received wide attention. The quality of information is defined in relation to forecast performance — i.e., how well forecasts predict the observations. Several quality parameters have been identified, representing the desired characteristics in terms of product performance. Among the most widely examined parameters are: lead time, accuracy, reliability, and forecast skill.

Lead time refers to the time lag between the prediction and the predicted event. The desired characteristic here is the length of the lead time, the longer the better. The lead time of different CIPs may vary from a few hours (e.g., short term routine weather forecasts), through a few months (seasonal forecasts), to several decades (long term climate projections). When the lead time increases, as a rule, trade-offs have to be made in terms of other quality parameters such as accuracy, reliability, and forecast skill, that determine the level of confidence attached to the prediction.

Accuracy refers to the level of agreement between prediction and observations (data). It is measured in terms of the difference between the true value (observation) and the prediction. The difference is known as forecast error. In the same vein, reliability is defined as the average agreement between forecast values and observed values. From a decision-making perspective, it refers to how well forecasts will be able to improve outcomes of decisions. Finally, measures of forecast skill provide a statistical evaluation of the relative accuracy of a forecast over some reference forecast. The norms used for references are persistence (no change in condition) and climatology (typical conditions in a given month). The type of references used may vary according to the type of forecast: e.g., short term weather forecast (persistence); seasonal forecasts (climatology). Forecast skill is mainly concerned with the increase in accuracy due to smartness of the forecast system, rather than accuracy due to easiness of the prediction.

The improvement of quality parameters of CIPs needs employing best practices in forecast methodology. The forecast quality has to be measured through a process of validation and verification. Different verification systems can be used; the WMO standard verification system of long range forecasts is a widely used system.

Value of CIPs

The value of forecast information is assessed with reference to benefits accrued to users by decisions taken with the aid of an information product. The value of forecasts justifies the investment on CIPs. Assessing the value of forecast information involves several conceptual and analytical difficulties. The essence of the idea is how much value is added to decision outcomes achieved with the aid of forecast information, relative to decision outcomes achieved without the guide of forecasts. A variety of approaches have been used to estimate the value of climate information (forecasts). One measure of value is the expected value of forecast information (EVFI) – defined as the difference between the expected value of the outcome from a forecast-assisted decision, and the expected value of the outcome of a decision taken without the guidance of a forecast.

As already mentioned, CIPs are public goods in nature, and therefore limited incentives are available for private providers to supply them through a market driven mechanism. Hence, state or non-profit agents are usually involved in the supply and delivery of CIPs. Assessing the value of CIPs becomes an important step in the value chain, since it provides the main source of justification for making investments on CIPs in the absence of market based pricing mechanism to exchange products.

8.2.4 Delivery of Climate Information Products: Communication

Among the other factors that affect the demand for CIPs, factors connected to the delivery of products are the most important. Delivery implies the communication of information between providers and users. The delivery of CIP involves a two-way communication between providers and users. The primary path of communication is conveying the forecast message to users. Nevertheless, given the public good nature of CIPs, reverse feedback communication from users to providers can also be considered as highly important. Otherwise, due to the absence of a product exchange based on a price mechanism, there is no way to signal the important messages about quality and value of products.

There are a number of important issues involved in the delivery (communication) of CIPs. Among them are the format and content of the forecast message; availability, access, and targeting of products; and media of dissemination.

In terms of the format and content of forecast message, forecast products are probabilistic in nature and always carry some level of uncertainty. Hence, their usefulness is determined by the level of confidence attached to them. Overestimating (overconfidence) as well as underestimating (poor confidence) the accuracy and reliability of information could lead to erratic decisions with significant losses. Therefore, effective communication needs a balanced coverage of the level of uncertainty and applicability/limitations of CIPs. This is a matter of format and content of CIPs.

In terms of availability, access and targeting, the effectiveness of CIPs is determined by the availability of products, and easy access to them by users. Otherwise, even the information generated with sophisticated methods of forecasting could be wasted without being used by target users. Finally, the media of dissemination is closely associated with the issue of availability and access. Quite often, the CIPs are delivered through public media such as TV, radio, newspapers, and Internet. Research suggests that the relative importance of different media vary with the type of CIP. It seems that electronic media such as TV, radio and Internet has captured the highest attention. Pilot schemes are also being tested on specialized channels such as mobile phones (e.g., SMS messages), targeted at specific user categories in some countries.

8.2.5 Users' Forecasts and Beliefs: Substitutes or Complements?

Another important area is users' local forecasts and beliefs on the climate system as a guide to decision-making. Communities such as farmers and fishermen, have been facing climate uncertainty long before the current scientific knowledge about climate and forecasting methods more developed. Such communities were taking day-to-day decisions under the guidance of local forecasts, that helped them to form expectations regarding the climate events to come. These forecasts are based on indigenous systems of knowledge and methods of prediction about local climate, that have been shared by communities as local beliefs. They can be considered as farmers' models — generalized and simplified versions of experienced patterns of climate over long periods of time (over generations) — that give some predictability about local climatic variability, thereby helping to plan regular livelihood activities. Studies have found that such beliefs carry expectations about the beginning of rainfall (season), onset of rainfall, duration and distribution of rainfall events, dry spells, end of rains, and a knowledge of local indicators that help predict oncoming climate events. Some have called such beliefs as naïve forecasts, compared to climatological forecasts based on formal methods of analysis.

Studies on local beliefs suggest that they may contain many favourable characteristics that serve as a useful guide to decision-making. According to recent behavioural economic findings, the methods used by local communities appear to be based on heuristics — mental shortcuts or 'rules of thumb' commonly used to make probabilistic judgments by decision-makers. Heuristics have certain advantages, subject to limited information processing capacity of decision-makers. However, decisions based on heuristics are usually associated with cognitive biases, and local beliefs on climate are not an exception. Researchers have suggested such biases are analogous to cognitive 'illusions' — errors being made without knowing about them.

Research on local climate beliefs and forecasts has raised a few important points that are relevant in the case of CIPs.

- Such beliefs are founded on generations of experience about the local climate. Evidence from many developing countries indicates that farmers are still using them widely in their regular farming decisions.
- Recent behavioural studies suggest that they serve as an alternative system of decision tools, based on subjective processing of individual and group experiences (experiential processing), compared with analytical processing of systematically gathered weather data upon which CIPs are based.
- Local forecasts could serve either as complements or substitutes for CIPs. As complements, they can fulfil an important role by serving as prior subjective distributions to be updated by forecast information. This is an essential step in a heuristically-driven process of probabilistic decisions, usually practiced by non-expert decision-makers. On the other hand, in the case of CIPs which are not compatible with farmers' decision context, local forecasts may compete with formal forecasts and substitute them. They may be given preference over formal forecasts due to the appealing characteristics of local beliefs, in terms of compatibility with farmers' decision-making behaviour.

8.3 Climate Information in Sri Lanka

The Department of Meteorology (DM) is the nationally mandated CIP provider in Sri Lanka. It has a mandate for the provision of weather and climatological services for national development, general public, and stakeholders in sectors such as agriculture, energy, fishery, shipping, aviation, and insurance. These services are concerned with offering CIPs routinely on a daily/weekly, monthly, and seasonal basis. In addition, the DM issues warnings and advisories on bad weather situations due to events such as cyclones, heavy rains, lightning, and high wind. Its mandate also covers undertaking studies on climatology and climate change that lead to offering specialized products, such as long term projections of climate change. The DM has a country-wide network of own meteorological stations. It also maintains a large number of agro-meteorological units with the collaboration of other agencies dealing with sectors such as agriculture, plantations and irrigation. It is the national representative for the WMO, and the focal point for the IPCC. In addition, it is represented in a number of regional forums on climate, such as the Tropical Cyclone Panel for Bay of Bengal, SAARC Meteorological Research Centre, the Asia-Pacific Network for Global Change Research, and South Asia Seasonal Climate Outlook Forum (SASCOF). Overall, the DM can be considered as the primary source of all forms of CIPs originating in Sri Lanka. Hence, it is the primary source of supply in the value chain of CIPs in Sri Lanka.

The DM presently offers a limited portfolio of CIPs which are channelled via public media and through its own website. It routinely issues short term weather forecasts on a daily basis under three categories: public weather forecasts, sea-area forecasts, and city forecasts, which are updated regularly at intervals of a few hours. Public weather forecasts are concerned with short term prediction of likely events of showers, thundershowers, lightning, and wind, on a broad geographical coverage at province or district levels. Sea-area forecasts, targeting fishermen and naval operations in particular, cover likely events of showers/storms, with direction and speed of winds in selected areas in the coastal belt around the island and adjacent sea areas. City forecasts provide daily forecasts of minimum and maximum temperature, relative humidity and likely events of rainfall for major urban centres. Those forecast products are mainly based on information obtained from satellites, observations made at weather stations around the country, and model outputs of major global centres.

In addition, the DM has recently launched the 'Monsoon Forum' which is aimed at providing a seasonal outlook with a lead time of around 3-6 months in the two monsoons periods – south-west monsoon and north-east monsoon. The Monsoon Forum includes the participation of several state agencies, responsible for agriculture, plantation, irrigation/water management, disaster management, and defence. The major information products offered by the Monsoon Forum include: (i) overall forecast on total rainfall for a given monsoon season under three classes of climatological probabilities: below normal, normal and above normal; and (ii) experimental monthly rainfall forecasts (average rainfall in mm ±10%) for all districts under the same three classes of climatological probabilities.

These predictions are based on multi-model forecasts published by international climate agencies on reviewing observations on global climate conditions such as ENSO, MJO, IOD, and other relevant phenomena. The forecasts are initially conveyed to stakeholder agencies bi-annually in the Monsoon Forum and their feedback is obtained. Subsequently, forecasts are made available to the agencies for their decision-making purposes.

The above are the core products of climate information currently available in Sri Lanka. In addition, some complementary products that play a supportive role in decision-making on climate related issues also are available. One of them is the classification of agro-metrological zones published by the Department of Agriculture. Based on long term records of local rainfall and elevation classes, the country has been divided into a number of agro climatic zones. This has become a standard CIP used by agricultural and irrigation agencies for decision-making, such as recommendations of crops/agronomic practices, and irrigation management.

The recent upsurge in climate change research has generated a number of research outputs that can be considered as specialized CIPs. Accordingly, locally downscaled versions of long term climate change projections for rainfall and surface air temperature have been developed under selected scenarios. The projections are available for target years such as 2025, 2050, and 2100. In addition, several studies that analyzed emerging trends in weather patterns based on historical records of meteorological data have also appeared. Information generated by such projections and trend analyzes have limitations in terms of confidence levels and applicability for practical decisions. Nevertheless, they can be considered as essential forward looking steps towards developing a viable system of CIPs in the long run.

While the research findings on actual use of available CIPs are scarce, a survey conducted by the IPS in village tank farmers in Anuradhapura district has shown that 73 per cent of farmers regularly look for daily weather reports in the public media. However, the share of farmers who ranked media

Table 8.3
Information for Climate Expectations in Farming Decisions of Village Tank Farmers

Source of information on climate for farming decisions	Ranking (%)		
	1	2	3
Expectations based on personal observations	86.7	10.5	-
Information acquired from interactions with fellow farmers	8.8	71.8	12.8
Weather information from media	2.8	12.2	70.2
Information from local officers	-	1.7	0.6

Source: Senaratne, A., (2011), "Survey on Farmers' Perceptions and Adaptation to Climatic Variability and Change in Village Tank Systems in Dry Zone of Sri Lanka", unpublished survey, IPS.

weather reports as the major source of information is only 2.8 per cent, falling far short of the numbers that ranked personal judgment/observations (86.7 per cent), or interactions with fellow farmers (8.8 per cent) as the major source (Table 8.3). The information given in Table 8.3 suggests that farmers mainly rely on climate expectations based on personal observations. They are further assisted by interactions with fellow farmers too. While many farmers look for weather information from media, their assessment of the role of media information in making actual decisions was low.

To some extent, the high rankings assigned to personal observations and interactions with fellow farmers indicate the importance of locally shared beliefs about climate in farmers' decisions. A study documenting some aspects of local beliefs on climate shared by village tank farmers suggest that many regular farming decisions are guided by local beliefs.[3] Accordingly, farmers' beliefs consisted of the following key components:

Beliefs about local seasons: A core component of farmers' beliefs on local climate is the seasonal agricultural calendar with two traditional farmer-defined seasons known as Maha and Yala. Local farming system activities are primarily centred on the two seasons. Beliefs on seasonality are associated with normal expectations about the onset of seasonal rains, duration and intensity of rainfall, dry spells and the end of rains. Farming activities are usually organized according to the beliefs about the seasonality of rainfall.

Beliefs on intra-seasonal distribution of rainfall: Farmers' beliefs also cover intra-seasonal events of rainfall and dry spells sequenced in order of calendar months (originally based on the local lunar calendar) connected to temporal milestones of religious and cultural events. Farmers had specific local terminology to describe the nature of events (i.e., intensity and time/duration).

Beliefs about local indicators that predict the oncoming climatic events: Farmers share a set of beliefs about local indicators on climate. It consists of observations on the local environment that are interpreted as signs of oncoming events of climate (rainfall). They constitute a local system of forecasting, with indicators having different lead times towards expected events. Such indi-

[3] Senaratne, A. (2013), "Shared Beliefs, Expectations and Surprises: Adaptation Decisions of Village Tank Farmers in Sri Lanka", unpublished PhD thesis, Deakin University, Australia.

cators include phenomena such as observations on wind, sky and clouds; local hydrological phenomena (e.g., spilling time of tanks); thermal changes in the environment; cosmological observations; resurgence of indicator species and observations on behaviour of animals and local fauna.

Interviews and discussions with farmers confirmed that they still use local beliefs in regular decision-making on farming and other aspects of daily life. However, a majority of farmers (89 per cent) expressed that established patterns of rainfall are changing, and the reliability of local forecasts could decline over the time.

8.4 Climate Information Gap

An assessment on the current situation helps to identify specific gaps in climate information in Sri Lanka. Gaps are identified and discussed using a value chain framework in the following sections.

8.4.1 Supply Gaps of CIPs

The current supply of CIPs in Sri Lanka can be considered as limited compared to demand available in various sectors where CIPs can be used to improve decision outcomes in a gainful manner. A few areas where the scarcity of climate information has been felt severely, are agriculture, water resources management, energy generation planning, and disaster risk management. The list is not exhaustive and decisions taken in several areas of economic activity could be expected to benefit from a rational use of CIPs. Overall, the gains in value expected from a sensible use of CIPs in various economic sectors appear to be significant, and compared to potential demand, the existing supply of CIPs can be considered to be strikingly low. The supply improvements can be expected in range, quality, and accessibility of products.

The supply gaps originate mainly from constraints faced by providers of CIPs that include the DM, and other relevant stakeholder agencies. The provision of CIPs is an advanced technical process that requires state-of-the-art technical facilities and a high level of expertise. To achieve the necessary levels of facilities and expertise, substantial investments are needed. As a result, establishing and maintaining reliable systems of forecasting is a challenge to many developing countries. Sri Lanka is not an exception. Even though the DM has made a conscious effort to upgrade its facilities and range of CIPs over the years, the limited availability of resources has constrained its capacity to meet the challenge. Overall, it is reasonable to assert that insufficient investment on facilities and skills development in the DM and other stakeholder agencies is a key reason for the current gaps in the supply of CIPs.

8.4.2 Credibility Gap of CIPs

The availability of CIPs alone is not sufficient to generate value from adaptation decisions. They need to be credible products, acceptable to users so that they can be effectively used for generating value. Two aspects that critically determine the credibility of CIPs are the compatibility and quality of products. Compatibility refers to the gap between coverage of existing forecasts and the information needs of users. Quality refers to the performance of forecasts in terms of the accuracy and reliability of predictions. Compatibility and quality issues jointly contribute to the credibility gap, which is concerned with how users assess the value of CIPs. If the credibility of products is high, expected value and demand for products increases, whereas the opposite applies for products with low credibility. The credibility gap, on one hand, is an issue which is closely related to supply constraints faced by providers.

Table 8.4
Farmers' Assessment of Issues/Problems of Media Climate Information

Problem/Issue	% Farmers
Failure of forecasts	24.9
Not locally focussed	3.4
Low confidence	7.2

Source: Senaratne, A., (2011), "Survey on Farmers' Perceptions and Adaptation to Climatic Variability and Change in Village Tank Systems in Dry Zone of Sri Lanka", unpublished survey, IPS.

Table 8.4 presents a summary feedback from village tank farmers regarding the CIPs currently available from the public media.[4] A few factors that contribute to low credibility on weather forecasts can be identified according to their responses. Farmers have observed failures in forecasts and have low confidence in them. A few farmers stated that lack of local geographical focus makes them less useful. This issue was particularly stressed in FGDs held with farmers. According to them, the media usually covers the province or district as a whole, but wide variations in rainfall could exist even within the province/district. As a result, weather forecasts in the media cannot be fully relied on for making regular farming decisions.

The discussions further revealed that farmers usually give relatively high attention to the media when events such as extreme rainfall events, floods, cyclones, and tropical storms take place. Such events normally cover wider geographical areas and often lead to hazardous consequences. They often occur as surprise shocks against normal expectations about climate, and farmers find that information from local observations/fellow farmers alone is not sufficient to face such incidents. Hence, farmers give a higher weightage for information from the media on such occasions.

Overall, it seems farmers use CIPs available from the media selectively, depending on the type of events they face, and the nature of decisions involved. They find routine weather information currently available from the media to be less reliable for usage in regular farm decisions. Nonetheless, they appear to rely more on information from the media when they face climate shocks.

8.4.3 Gaps in Communication (Delivery) of CIPs

Another gap in climate information can occur in communicating CIPs to target users. The communication gap refers to issues concerned with: (i) format and content – i.e., whether or/and how users understand the probabilistic nature of climate forecasts; (ii) availability, access and targeting – i.e., whether a given product is communicated to target users; and (iii) media of dissemination – i.e., how effectively products are communicated to target users.

Format and content is closely associated with the problems of compatibility and, therefore, connected to the credibility gap also. Communicating probabilistic forecasts has become an important research area and several studies have been conducted regarding formats and content suitable for specific user groups. Some of these studies have been focussed on users with low education and literacy levels in Less Developed Countries (LDCs), thereby demanding extra care in designing CIPs for illiterate users. The situa-

[4] Only about 35 per cent of farmers offered responses to the relevant questions.

tion in Sri Lanka can be considered somewhat favourable in this regard, due to a high level of literacy and formal education facilities available even in remote locations.

A second and third set of issues with regards to the communication gap are closely connected to the effective channelling of CIPs to users. Studies in certain countries have shown that electronic media has a major role to play in communicating CIPs. Radio and TV are the most widely used channels of communication of CIPs. The Internet also is becoming popular, especially among urban user groups. A survey conducted by the Ministry of Environment on public perceptions of climate change in Sri Lanka, has reported that TV is the main source of information for both urban (96 per cent) and rural (93 per cent) population, followed by the radio [urban (61 per cent), rural (79 per cent)], and newspapers [urban (79 per cent), rural (68 per cent)].[5] In the survey of village tank farmers, 89 per cent and 97 per cent farmers in the sample had TV and radios respectively, in their houses.

The above suggests that in Sri Lanka, TV can be considered as the most appropriate media for communicating CIPs, followed by the radio. Several TV and radio channels in Sri Lanka offer daily weather reports at the end of regular news bulletins based on the DM forecasts. In addition, both radio and TV channels report weather information as prominent news items on special occasions, such as extreme events. No studies have been conducted to assess the effectiveness of reporting climate information by electronic media in Sri Lanka. An area that needs research attention is on the communication gaps that can occur due to inaccurate, sensationalized coverage of climatic events and trends in the public media.

8.4.4 Declining Reliability of Local Belief Systems

Another aspect relating to the climate information gap is a gradual decline in the reliability of local beliefs on climate. Nearly 89 per cent of respondents in the sample of village tank farmers, expressed that they perceive long term changes in the local rainfall patterns. According to them, rainfall patterns in the area have undergone significant changes, and have become less predictable. As a result, some of the beliefs about local weather patterns have become obsolete and less reliable. In the FGDs, this view was particularly stressed by farmers with long term experience in farming in the area. They suggest that local weather patterns have become more random, and surprise events are more frequent than earlier. In addition, due to the commercialization of local economies, and the spread of modern agricultural technologies, the local environment has changed significantly. Due to changes such as clearing of local forest patches, some traditional indicators have become rare observations that cannot be relied upon for regular farm decisions. Overall, a decline on the reliance of local beliefs on climate, creates a vacuum that widens the climate information gap further. This extra gap has to be filled with suitably designed CIPs.

8.5 Bridging the Climate Information Gap

Bridging the climate information gap is an essential step in facing the threat of climate change. To achieve this, certain management and policy measures are necessary. In this section, a brief overview of essential major steps towards bridging the information gap is presented.

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[5] Ministry of Environment (2010), "Public Perceptions of Climate Change in Sri Lanka: Findings of a Country-wide Survey in Sri Lanka", ADB Technical Assistance Project 7326-SRI: Strengthening Capacity for Climate Change Adaptation, Climate Change Secretariat, Ministry of Environment, Colombo.

8.5.1 Overcoming the Supply Constraints of Providers

The primary step in bridging the climate information gap is overcoming the supply constraints faced by the providers of CIPs. The DM is the primary provider of CIPs in Sri Lanka. Therefore, building the technical capacity of the DM is an essential step to overcome the information gap. This requires investing funds for upgrading technical facilities of the DM, recruitment of additional staff, technical assistance for launching sophisticated forecast models, building skills of staff by training, networking with global/regional/national agencies operationally, and building its research and development capacity. Given the advanced technological components involved in capacity building efforts, technical assistance of developed nations, and international agencies is essential here.

8.5.2 Improving the Quality and Value of CIPs

Overcoming the credibility gap of CIPs is an area that requires special attention. The CIPs are imperfect products that require constant improvement. Range and product quality should be upgraded continuously. Hence, product development has to be linked with an effective validation and verification process. This cannot be achieved by improving the technical capacity for producing forecasts alone. It has a strong socio-economic component that covers areas such as assessment of user information needs, appraising users' feedback/acceptance, and estimation of the economic value of products. Several pilot projects and action research programmes have been conducted in developing countries and feedback from such studies are being used to improve the CIPs. This is a continuous process that has to be supported by an efficient research and development programme.

8.5.3 Developing Effective Communication Channels

Capacity building of information providers and product quality improvement should be complemented by developing effective communication channels. As far as the public media is concerned, widespread access to TV and radio even in rural areas is a definite advantage. Another advantage is the high level of literacy of users. These advantages should be exploited to communicate a credible range of products to end-users in an efficient and timely manner. The communication of forecast products has been a well-researched area. The necessity of norms and best practices of communicating probabilistic CIPs have been identified, and are being continuously developed. The communication of CIPs should be based on such norms and best practices, and also be supported by effective feedback mechanisms. Current research is also exploring the feasibility of communication channels that are targeting specific user groups. Connectivity through mobile phones is one potential way for channelling user specific information. The recent spread of mobile networks, and a rapid increase in phone users even in remote areas, provide a fertile ground for the growth of such experimental channels of communication.

8.5.4 Integrating Formal and Local Systems for Enhanced Performance

The strengths of forecast products should be integrated with local systems of user forecasts to achieve better outcomes from adaptation decisions. Despite the declining reliability of local belief systems due to changes in local weather patterns, such belief systems have developed in response to users' own experiences about the actual information needs of day-to-day decisions. Given that the information is developed based on the needs of actual decisions and personal experience, such beliefs may contain many desired characteristics as decision-support tools, in spite of certain biases that may be associated with them. On the other hand, CIPs based on climatological forecast systems are products of analytical processing of data by experts who are not the real users of the information. Therefore, some characteristics (e.g., format and content) of CIPs may not be behaviourally appealing to the actual users, as their own belief based forecasts. In essence, the CIPs based on scientific forecast systems and local forecasts based on shared beliefs have their strengths and weaknesses. If the strengths of both can be integrated by carefully studying them, a more effective system CIPs could be developed. Therefore, it is necessary to integrate formal and local forecast systems in ways that complement each other, so that better decision outcomes are achieved.