New developments in climate information

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Lead

Recently established international climate finance mechanisms and aggravating impacts from climate change bring along new roles for climate observations: for *climate justice* – enabling countries to make their case for compensation; and for *empowerment* – enabling countries to plan appropriate adaptation and mitigation strategies. Assessing different sources of climate observations and their suitability for these new roles, we find urgency to extend and maintain existing networks of observatory stations.

Opening thoughts

For local farmers, the transition from the dry to the wet season in the Andes of Peru begins by repeated drizzle, gently moistening the soil and preparing it for the seeding of potatoes and other crops (see the recent study by Gurgiser et al. 2016). The great importance of this particular type of rainfall for their agriculture is reflected in its ancient Quechua name, *puspa*, which is still used today. Farmers consistently report a delay and shortening of these *puspa* days, which challenge their traditional way of crop cultivation. Interestingly, when trying to identify the *puspa* days from meteorological observations, it turns out that available weather station data of the region does not allow to detect these small amounts of intermittent precipitation. Should the necessary adaptation to these changing rainfall patterns justify support from international climate finance mechanisms?

One of the major climate finance mechanisms, the Green Climate Fund, has in its investment criteria (GCF 2016), as a main criterion, the urgency for support of a specific country (termed *"Needs of the recipients"*). Here it mentions explicitly *"Intensity of exposure to climate risks [...] including the exposure to slow onset events"*. The reported delay of the *puspa* rains in the Cordillera Blanca would certainly count as such a slow onset impact, but should the Green Climate Fund accept a claim that cannot be supported with more quantitative observations?

The role of climate observations as a prerequisite for claims to establish climate justice is new and adds to their traditional importance for scientific understanding. Another role concerning empowerment of developing countries to develop appropriate adaptation and mitigation strategies, is gaining importance from ongoing climate change.

From these new roles for observational climate data, the extension and maintenance of existing weather station networks become even more important. The combination of strongest climate change impacts and at the same time disposing of inadequate monitoring networks in many developing countries (see Figure 1) makes their extension particularly urgent.

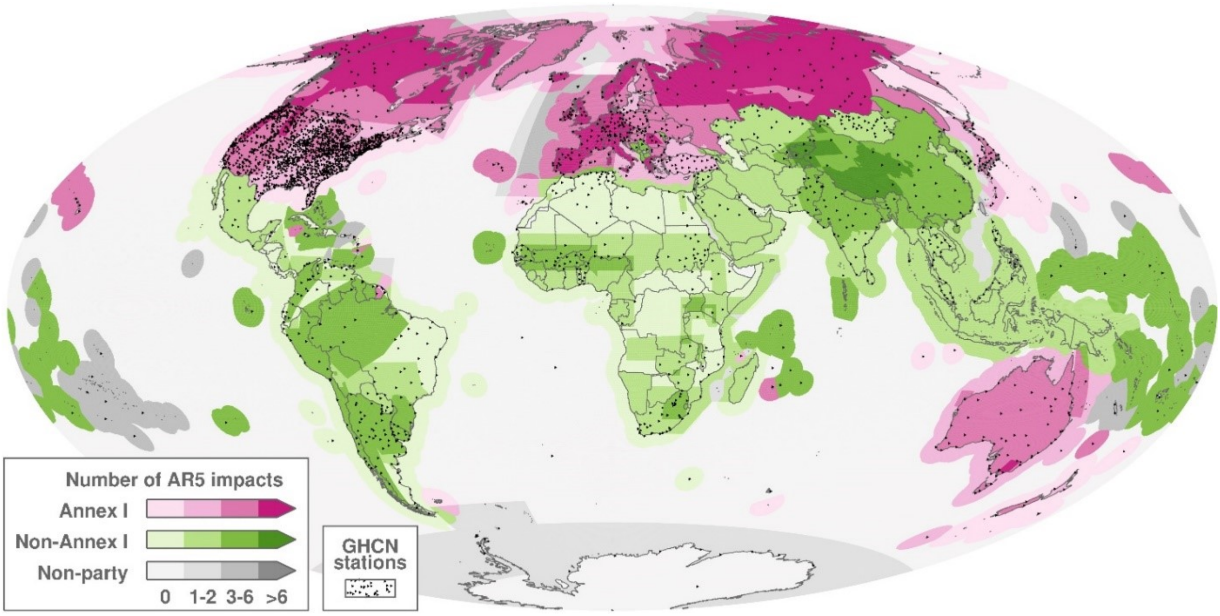

Figure 1: Climate stations from the GHCN network in Annex I countries (red) and Non-Annex 1 countries (green). Shades are indicative of the numbers of reported impacts in the 5th Assessment Report by the IPCC (Huggel et al. 2016).

Different sources of climate observations

Observations can be derived from three sources, in-situ observations such as meteorological stations or other monitoring sites, remote sensing observations from satellites, and knowledge of local people.

In-situ observations are the only ones which record truly local conditions and which provide long time series, which is essential to detect changes in climate beyond year to year variability. However, they are expensive and challenging to maintain, less so because of the costs of equipment but because of the demanding maintenance. Regular visits to the station by trained people are necessary even for automatic stations to ensure a continued operation. They furthermore depend to a certain degree on political and institutional stability, as can be seen in the disruption of many weather stations in former Soviet Union countries. Especially in developing countries, they are correspondingly scarce and scattered in space (see Figure 1).

Climate data from satellites on the other hand are cheap for users, except for the technical skills and computing infrastructure required for their handling, and have often (near) global coverage. A major drawback is that most records begin only at around 1990, limiting the temporal coverage of the past. In contrast to in-situ observations, they provide areal information, for example the precipitation of a 10x10 km^2 square (typical resolutions range between 1x1 and 25x25 km^2, depending on the satellite). When comparing e.g. such area-measured precipitation to the in-situ precipitation recorded at a station inside that area, one may find surprisingly large differences. This does not invalidate the satellite or the weather station but simply highlights the difference between point and areal measurements. It is therefore not straightforward to substitute one for the other.

"Local knowledge" finally is a data source available wherever people live. The access to such forms of knowledge can be challenging and an appropriate interpretation even more. Acknowledging the social, cultural or political context in which the knowledge is produced is crucial. For example, the above-cited farmers from the Cordillera Blanca also reported increased occurrences of ground frost in the sowing months of September and October (Gurgiser et al. 2016). This local knowledge observation is in contradiction to all measured temperature observations, which highlight warming temperatures. How should one interpret such discrepancies? Obviously, the perception of increased frost occurrence reflects more influences than ground temperature, which in the end produce these contradicting observations. The danger lies in ignoring this context and taking the farmers' observation at face value for ground temperature. The example makes it evident that observations from these different sources generally cannot be substituted for one another.

It is important to note that the three sources capture different aspects of reality and are thereby complementary to each other. Although analysing them together does necessarily produce converging conclusions, there should be no preference for one over the other, since only in combination they can provide a more complete picture (Figure 2).

Importance and employment of climate data

One traditional use of observational climate data is for understanding and quantification of climate change and its impacts, be it with respect to temperature increases, changing extreme, impacts on glaciers and water resources, or changing and new types of hazards. Remote sensing (satellite) data and local knowledge ideally complement local (scientific) observations to achieve a more comprehensive understanding of climate change impacts and the socio-environmental context relevant for designing actions on the ground. In fact, from ongoing climate change and its augmenting impacts, this understanding becomes increasingly relevant at the local, national and regional levels, feeding into adaptation measures.

To illustrate this, we draw again on an example from the Andes of Peru: Shrinking glaciers in the Cordillera Blanca create major challenges both for a sustainable resource management (slow onset: decreased water availability during dry season) and the management of natural hazards (climate risk: outburst floods from newly formed glacier lakes). The latter could be addressed by designing early warning systems to alert downstream local population in case of an outburst flood, for which available locally deployed meteorological, hydrological and geophysical instruments are a key component. New approaches are now tested to integrate also satellite remote sensing data which provide important information on the (in-)stability of glaciers, bedrock or sediment slopes. While long-term observations can be useful for early warning systems in terms of better understanding the longer-term developments, they are not an indispensable part. This is different for sustainable water management which requires long term observations of climate, hydrology and water consumption for a reasonable understanding of water availability and demand. Such observations being absent, management needs to rely on unverified ad-hoc assumptions.

Sustainable water management challenges under additional climatic stressors are not unique to the Andes but widespread around the world, and acute in many parts of the developing world. For instance, water management in the trans-national Indus basin of India, China, Pakistan and Afghanistan, faces similar challenges. Substantial amounts of its waters stem from snow and glacier melt in the Himalayas, a contribution which is, however, still difficult to quantify due to lacking observations in these hardly accessible areas. As a consequence, estimates of future water availability are burdened with large uncertainty, adding difficulty to designing and implementing local to regional scale adaptation.

At the international level, both instrumental in-situ observations and remote sensing climate data have played a determinant role to foster understanding of the climate system and climate impacts, feeding e.g. into the IPCC process and ultimately into global climate policy as negotiated at the Conferences of the Parties (COPs). See upper part of Figure 2.

Additional relevance for multiple source climate data, which is just emerging, concerns climate justice and empowerment (see lower part of Figure 2). International funding mechanisms that support climate change adaptation and mitigation, such as the Adaptation Fund and especially the Green Climate Fund, have only recently become operational and are still in their spin-up phases. If asked to support an intervention, they require evidence for that intervention's necessity. And although it is not explicitly specified which of the three sources of climate observations are to be preferred, having measured data at hand would most probably strengthen a claim considerably. Local knowledge can support a claim additionally, but due to the lack of comparability across locations, basing a claim on local knowledge alone seems challenging.

A country's empowerment to assess its climate risks and develop appropriate national strategies of climate change adaptation and mitigation relies equally on a sound data base. While here as well measured data is essential, local knowledge must play a key role in the planning process. Experience shows clearly that any implementation which ignores context and perceptions of the concerned local people is probable to undergo substantial difficulties and has a much higher likelihood of failure.

These two new applications for climate data will become increasingly important, with international climate finance mechanisms gaining momentum and aggravating impacts from on-going climate change.

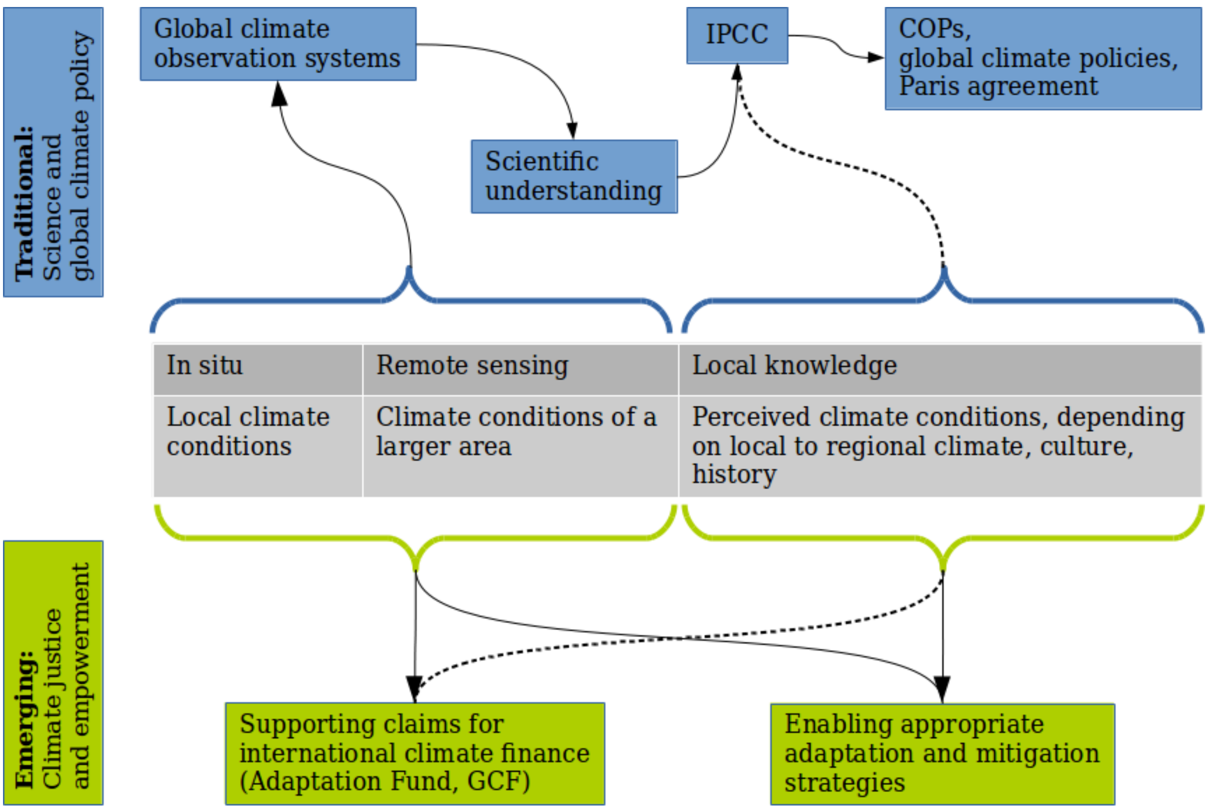

Figure 2: Observational climate data and their relevance for science, policy, climate justice and empowerment.

Conclusion

Understanding the genesis of local knowledge is an ongoing endeavour of social and anthropological sciences. The increasing popularity of referring to local knowledge (Ford et al. 2016) makes this understanding more and more important. So far, however, local knowledge has often been seen only through the lens of the physical environment, which ignores the many non-physical influences which equally determine what in the end results as "local knowledge". A better understanding of these processes is crucial for any adaptation and mitigation planning.

However, using local knowledge as a base for funding decisions, as they are taken by the Adaptation and Green Climate Funds, brings enormous challenges. Countries, and international cooperation, are therefore well advised to extend and maintain their networks of climate observatories in order to dispose of comparable data to underpin their claims for support and compensation. Creating or extending capacities for using remote sensing data further supports their position.

While remote sensing technology advances at a fast pace, providing more and more data sets with global coverage at low or no cost, and local knowledge awaits its appropriate documentation, in-situ observatories are generally in a weak position due to high installation and especially maintenance costs. They are however only to a certain degree replaceable by remote sensing data, and therefore essential for both a refined understanding of climate and environment, and to put countries which are affected by climate change in a stronger position to make their case.

Although this observatory focuses on climate observations, the same reasoning applies for any kind of environmental data and economic and societal data as well – the more and better data a country has at its disposal, the stronger its position to claim funding for adaptation and mitigation (role for climate justice) and to define and implement corresponding strategies (role for empowerment).

References

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