

Integrating the water demand approach in the planning practices to face drought risk in the Potosí district (Bolivia)

Guido Minucci¹, Lorenzo Chelleri²

Abstract

There is not agreement with reference to drought definition (Palmer, 1965; UNCCD, 1994; Wilhite, 2002; Mishra and Singh, 2010) and it has direct consequence in the lack of a common and shared strategy to cope with such hazard. Nevertheless, drought can be considered as a typical slow-onset phenomenon, which operate at different temporal scales, from days to years and these are relevant depending on water resources and uses of interest. The traditional supply-driven water management approach views the water needs of the community as “requirements” that must be met and not the “demands” that are changeable (Gleick, 2000; White, 2006; Kampragou et al., 2010). This traditional approach has led to over-use of the resources, overcapitalization, pollution and others problems of varying severity (Pahl-Wostl, 2007). With reference to our case study, we illustrate the analyses of different applied measures related to the water demand approach to increase the resilience of the community in the area of Uyuni and Tomave (Potosí district, Bolivia) to face droughts and desertification. On one hand, the local knowledge integrated with expert knowledge have been used to develop an early warning system in order to monitor and provide early warning of an emerging drought to avoid or reduce the impacts of a drought event. On the other hand, within the water demand approach, a water pricing policy and a water meter campaign have been put in place to count the amount of water used by different users and to reduce wastage of water. Moreover, international support programs are implementing both irrigation systems to support the rain-fed agriculture and a more sustainable land use management to cope with future drought events and climate change effects affecting, in particular, water availability in this area. Consequently, the study highlights how the need to built resilience in water demand poses the challenge of building integration between the water sector and development planning, which are traditionally separated domains. Moreover, it underlines the importance of a shift from a reactive approach, which is still widely applied in Bolivia, to a proactive hazard management in order to cope with future events.

¹ Politecnico di Milano, Dipartimento di Architettura e Pianificazione (DIAP), Via Bonardi 3, 20133, Milano, Italy, email: guido.minucci@polimi.it

² Universidad Autónoma de Barcelona, Departamento de Geografía, Edifici B9-1054, E-08193 Bellaterra, Barcelona, Spain, email: lorenzo.chelleri@uab.es

1. Introduction

A clear, universal and shared definition of what can be labeled like drought has not been achieved yet (Palmer, 1965; UNCCD, 1994; Wilhite, 2002; Mishra and Singh, 2010). Nevertheless, looking into drought definitions, two main categories can be highlighted: conceptual and operational definitions. The former states in relative terms (e.g., a drought is a long, dry period), while the latter aims to identify the onset, severity, and termination of drought periods. Drought is often referred to as a creeping phenomenon due to the fact that the onset as well as the end of a drought are difficult to determine, the impacts of a drought increase slowly, often accumulate over a considerable period and may stay for years after termination. Consequently, it is necessary a change in the way of managing water as well as its integration within a participated spatial planning to assess the implications for water of new developments, proposed changes in land use and to adopt a proactive approach in order to face such risk.

2. Description of Study Area

The municipalities of Uyuni and Tomave lie in a plain at an elevation of 3,700 m above sea level in the (Potosí district, Bolivia) in the Southern Bolivian Altiplano. The altitude of the plateau as well as the presence of the Uyuni Salt Flat with a surface of 12.500 km² affect the weather and define many of the ecological aspects of the area. The area is characterized by an arid climate, with extreme temperatures that range from -20°C to 30°C. The air is thin and transparent, thus the irradiation is high, while humidity is low reducing heat diffusion. Furthermore, winds in the region are very strong (can reach speeds exceeding 90 km/hr) all year, which have a relevant impact in terms of soil erosion. Consequently, a negative evapotranspiration and a deficit in rainfall (around 150mm per year) bring prolonged drought, cause a very irregular rainfall. The probability to have a drought event in this area is one every two years (Statistic Service of Potosí District, 2011). Moreover, a high solar irradiation combined with wind cause rapid evaporation.

3. Climate Change Effects

The Bolivian population has always been exposed to extreme hydro-meteorological and climate variability, particularly the influence of El Niño (ENSO), which regardless of climate change occurs periodically in different areas of the country (World Bank, 2010). According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), arid and semi-arid regions are particularly sensitive to possible decreases in rainfall. The IPCC (2007) estimates that increasing the temperature to South America will be between 1.8°C-4.5°C and precipitation changes from -12 to +12% by 2080. Although the manifestations of climate change in Bolivia are still little studied, the contributions are based on: a) scientific observations point b) local perceptions little systematized, and c) generated according to climate models that still have high levels of uncertainty. Besides

demonstrate acceleration in the increase of temperature, Vuille & Bradley (2000) and Francou et al. (2003) observed a clear relationship between the melting of glaciers and El Niño events. Also, a study of the National Climate Change (NPCC, 2007) complements this temperature rise in the Andes from observations on the incidence of malaria in highland communities. The IPCC (2007a) adds that the increase in atmospheric temperature has led to an acceleration of glacier retreat in the Andean region, with consequent impacts on water availability and the generation of hydroelectric power. According to Ramirez et al. (2001), higher temperature increases in the coming years will affect considerably the Andes. This statement has been sustained by a recent report regarding the effects melt glacier phenomenon on the communities living in the Bolivian Altiplano (Agua Sustentable, 2010). Whereas, in a study related to the impacts of climate change on the rainfall trends in Bolivia, Seth identifies a decrease in precipitation in spring (September-November), which would affect the water resources. This trend is coherent with what has been observed by a study conducted by the PNCC (2000) based on the Normalized Difference Vegetation Index (NDVI) showing a reduction between the months of September to October and increased in the month of November, which evidence of a shortening of the rainy phase. Consequently, such decline would be exacerbated by lack of management strategies, information on climate change and institutional constraints. Therefore, in this context, mitigation and adaptation mechanisms for sustainable management of water resources are critically needed.

4. Water Management: Changing Paradigm

The traditional supply-driven water management approach views the water needs of the community as “requirements” that must be met and not the “demands” that are changeable (Gleick, 2000; White, 2006; Kampragou et al., 2010). Gilbert White (2006): “The old paradigm of designing the cheapest reliable supply with little attention to demand determinants, pricing structures, and financing policies is no longer suitable. Moreover as it has been recognized that the traditional approach is unable to cope with rising water demand and meet changing standards in water uses (Kampragou et al., 2010). This traditional approach has led to over-use of the resources, overcapitalization, pollution and others problems of varying severity (Pahl-Wostl, 2007). Gleick (2000) underscores the significance of demand management, as a tool for adaptive water management, since the construction of large-scale water supply is hindered by social, economic and environmental constraints. Furthermore, given the nature of developing nations, much of the “saved” water will immediately be used by others, most obviously by “tail enders” on the irrigation canals or those with inferior riparian rights, or by women and small farmers who previously had less water than they needed for their livelihoods (Gumbo et al., 2005). A shift toward a water demand management approach may produce important impacts, such as enhancements in economic, social or gender equity, although the direct outcome is not an absolute reduction of water use. Hence, WDM do not aim just to change quantities and distribution of water, but if realized in appropriate ways it may have even impacts on the environment as well as enlarge participation in decision-making process.

4.1. Water Monitoring and Water Pricing

In the planning documents of the municipality of Uyuni which defines the vision for the future of the city, it is underscored how the sustainability of the water distribution service is still very fragile due to lack of investment to cover the largest percentage of claims and further the cost of water is based only on a low water consumption (PDU, 2007). Any differences in prices due to water usage in peak-hour usage or exceed amount of water consumed can be underlined and such regulatory practice is not taken in consideration for the future. Water pricing should be considered as a mechanism aiming to financial sustainability instead of a tool to regulate water allocation. Only if the financial costs are recovered can an activity remain sustainable (Savenije and van der Zaag, 2002). In 2007 the Water Cooperative of Uyuni (WCU) distributed through the pipeline water to 3,300 homes with a fee of 6.00 bolivianos (Bs) per five cubic meters of water. As underscored by WCU during the interview (09.2011), since 2007 to July 2011 the fee increased to 10.50 Bs for 8cm³, while, today, the price has risen at the quota of 13 Bs per eight cubic meters of water, which is the monthly average consumption per a family composed by (4-5 people). Furthermore, in 2007 only the 30 % of beneficiaries had a water meter, whereas since July 2011 a project (ending in 2013), which aims to install water meters in order to cover all the beneficiaries and to monitor the water consumption, has been up in place in Uyuni. Indeed, as pointed out by WCU the actual fees do not cover service costs. Thus it is necessary to regulate consumption (billed authorised consumption and unbilled authorised consumption) and revised the apparent losses unauthorised consumption and metering inaccuracies due to lack of investment to cover the largest percentage of claims and the cost is considered low for water consumption.

4.2 Education and Capacity Building

The Water Cooperative of Uyuni in collaboration with the municipality of Uyuni have identified and listed the priorities both for urban and rural area which aim to strength drinking water requirements, minimum equipment support for operation and maintenance as well as tracking and monitoring to ensure water quality (drinking). While, in rural as one of the main priority is to develop information campaigns to improve the sustainability of water projects and to involve a wider number of communities to contribute to exchange experiences between different programs working in drinking water and sanitation in the rural area. Notwithstanding, as stated by Gumbo et al. (2004), an important element in water demand management is to examine skills and the training needs of who compose and carry out water management programmes. Consequently, trained users and manager are a key factor to develop a worth conservatory plan. Since 2011 a project to increase the awareness of stakeholders, mainly with reference to householders and tourist facilities owners, has been promoted by the Water Cooperative of Uyuni. The campaign based on advertisement shows how the water-saving devices can contribute to saving water and promotes their installation. Awareness of rights and obligations by water users is

usually not so high. Thus, information campaigns on water-saving options at home, education programmes in schools and financing educational programmes among different stakeholders can stimulate a more active public participation in water-saving effort.

4.3. Water Management: The issue of water quality

The difficulties in the lack of coverage and quality of drinking water is a cause for the municipality low health profile, even if some differences can be highlighted between urban and rural area (PDMU, 2007). In the municipality of Uyuni the percentage of potable water coverage by pipes is around 69.32% while the different boroughs have the following drinking water coverage: 48.33% Coroma, Chacala 50%, 25% and Pulacayo Sows 90% (INE, 2005). Furthermore, the water supplied is not secure, there is neglect in the chlorination and disinfection, residual chlorine do not guarantee a permanent, operation and maintenance are not adequate, which means a growing deterioration of drinking water systems. Water pollution is one of the main problems and due to it is estimated that 80% of diseases are waterborne, childhood diarrhea are the leading cause of death (PDMU, 2007). Uyuni belongs traditionally to the mining sectors and the characteristic of such activity is to have a highly polluting discharges of acid mine drainage.

UYUNI						
	1992			2001		
<u>Houses</u>	Total	Urban	Rural	Total	Urban	Rural
number of home (Hogares)	7001	3191	3810	7203	3522	3681
number of housing (Viviendas)	4864	2655	2209	5130	2810	2320
<u>Services</u>						
with kitchen and bathroom	879	745	134	1536	1236	300
with kitchen or bathroom	2846	1312	1534	2867	1274	1593
no kitchet and no bathroom	1139	598	651	727	300	427
<u>Water source</u>						
piped	3363	2457	906	3556	2746	810
tank truck	72	19	53	2	0	2
well	959	72	887	1234	21	1213
Stream (or water surface)	365	12	342	288	1	287
other	105	84	21	50	42	8
<u>Water toilet drainage</u>						
drainpipe	262	162	100	636	580	56
septic room	273	262	11	144	119	25
other	556	516	40	966	706	260
no toilet	3773	1715	2058	3384	1405	1979

Table 1 – Housing Conditions in Uyuni (INE - Statistic Municipalities Atlas, 2005)

Furthermore, as it can be seen in the table 1 there is a relevant lack of a proper sanitary sewer system. In the town of Uyuni the extension of the water net is around 33%, while household connections reach 22% and the municipality does not have any wastewater treatment. It is worth noting that, on one hand, the municipality does

not have any wastewater treatment; while, on the other hand, even if 60% of the garbage is organic matter, the remaining 40% is composed mostly by solid waste such as household, commercial, hospital, industrial, which are deposited in rivers, streams as well as vacant lots and uncontrolled dumps resulting in an overall deterioration of the environment. While in the rural area “*curaca cobrador*”, who is elected by the community and is in charge for one year, has to manage and control of water distribution. In the rural area of Tomave, water to people living in villages is provided by two different systems: on one hand, piped system distribution, which delivers water to 1671 houses located in a village (44.8%); on the other hand, “*mingitores rusticos*” (well), which serves 685 houses located in a village (18.3%); whereas people do not live in villages extract water mainly from streams (36.1%) or “*ojos de agua*” (springs) (Table 2).

TOMAVE						
Houses	1992			2001		
	Total	urban	Rural	Total	urban	Rural
Number of Houses (Viviendas)	4861	0	4861	5014	0	5014
Number of Houses (Hogares)	3150	0	3150	3726	0	3726
Services		0			0	
with kitchen and bathroom	175	0	175	221	0	221
with kitchen or bathroom	2363	0	2363	2877	0	2877
no kitchen and no bathroom	612	0	612	628	0	628
Water source		0			0	
Piped	627	0	627	1671	0	1671
Tank truck	18	0	18	0	0	0
Well	551	0	551	685	0	685
Stream (or surface water)	1945	0	1945	1346	0	1346
Other	9	0	9	24	0	24
Water Toilet drainage						
drainpipe	29	0	29	23	0	23
septic room	6	0	6	17	0	17
Other	172	0	172	229	0	229
No toilet	2943	0	2943	3457	0	3457

Table 2 – Housing Conditions in Tomave (INE - Statistic Municipalities Atlas, 2005)

Furthermore, the data related to number of houses having a kitchen or a bathroom should be read in favor of the presence in the house of a kitchen as result by informal interviews done to local people in 2011 in the municipality of Tomave. Quality is a major problem even in the rural areas due to lacks both of quality management trainings to people and water quality instruments. The quality of water distributed is low because of its provenance from wells or springs and so it result not to be drinkable (chlorine) and to be sources of infection for people living in this region. Moreover, a decrease in precipitation, along with climate warming, may affect negatively the quality of water in rivers. Reduced water levels mean that pollutants

from point sources will become more concentrated. Consequently, in an area where the availability of water is already scarce, the amount of water available is unknown and a such situation of low water quality, an early warning system plays a key role in order to reduce the degree of the impact of a drought event, which has a probability to occur one every two years in this area (Statistic Service of Potosí District, 2011).

5. Quinoa, land degradation and desertification

Contemporaneously, the cultivation of quinoa, a grain-like crop farmed primarily for its edible seeds, is provoking changes in the land use with direct effects on the quality of the soil and indirect effects increasing drought vulnerability. Quinoa has been one of the main ingredients at the base of the Andean farmers' diet for thousand of years. Traditionally, the cultivation of quinoa was aimed at auto-consumption and the whole production process was conducted manually according to a well-defined methodology, which schedules to leave the land uncultivated for a long time. Such fallow period, around one year, has different purposes, such as restore soil fertility after harvest, and reduce the probability of disease. Although the most relevant is to accumulate water in the soil in order to sustain quinoa production characterized by using 2 years of rainfall during its growth period. This process requires at least 10 years due to the slowness of biological processes at this high altitude (Joffre and Acho, 2008). Nowadays, the role and the strategies to cultivate quinoa have been changed completely. Nevertheless, as consequence of this appraisal, a remarkable spread of the cultivation is imposing a relevant transformation in the land use of the countryside and in the social behavior. The high demand of the international market for this crop has increased the international prices. The price of quinoa sold by the farmer has almost tripled from 1999 to 2008, up to USD 2300/t (MDRyT, 2009). It pushes the producers to an extensive and unsustainable exploitation of soil and water due to a widespread and intensive one-crop agriculture in favor of the quinoa's export. Consequently, farmers' communities are losing the sense of being a community, which was characterizing this region, in favor of a more individualistic (or family) interest. Further, farmers prefer selling it and buying less nutritious food for themselves (Hellin and Hignan, 2005). Moreover, people attracted by the high price at the market of this product comes back in their villages of origin from the Bolivian cities for some months to cultivate quinoa to gain some money by selling this product without any kind of respect for this vulnerable land. Such attitude belonging to these people leaves the local communities to deal with the consequences of an inappropriate way of cropping, which is reducing the pastures and water for lama as well as accelerating the land degradation and desertification process. As result from the study developed by the Ministry of Planning for Development (Ministerio de Planificacion del Desarrollo), the desertification phenomenon covers 100% of the Potosí Department (MDSMA, 1996). Furthermore, to satisfy the rising world market demands the cultivation strategies have been changed. Firstly, crop-farming approach is moving from the ancient manual practices toward mechanized production system. Secondly, the increased use of tractors, especially with the disc plough and the sowing machine, has led to a severe degradation of soil fertility (PIEB 2009). Such practises have triggered a series of

changes that have aggravated the problem. These changes are: a) the rapid expansion of the agricultural frontier, b) the degradation of the vegetation and soil, increase in wind erosion, c) changes in surface albedo, d) increased frost and increased attacks on crops from pests and insects. All this has had adverse effects on agricultural yields and has also contributed to the process of desertification (Monasterio and Andresen, 1996). In 2010 several local institutions in coordination with local farmers have developed a project base on the plantation of *thola*, a native shrub that covers much of the southern Altiplano plain, to face the situation of accelerated degradation of soil and natural resources in the region due to the common erosive winds. Moreover, in 2012, two organizations of quinoa organic producers (ANAPCHI and ARPAIAMT) have defined for their affiliated farmers a set of rules and standards of production with reference to organic farming. Such norms tie the purchase of quinoa from these two organizations to the way of cultivation. Thus, a maximum extension for the cultivation of quinoa (30% for cropping and 70% for grazing) is established in order to reduce soil erosion and degradation. Those agriculture practices should be able to reduce in the long run the velocity of the process of soil compaction, which would permit a better percolation of water through the soil. Nevertheless, It is worth to underline that 20% of quinoa has been produced according to organic practices between 2010 and 2012.

6. Drought Early Warning System (DEWS)

It is often possible to provide early warning of an emerging drought due to the characteristics of such natural hazard. This information allows for a shift from reactive to proactive hazard management and represents a change in focus from disaster recovery to disaster prevention. A survey conducted by ISDR Platform for the Promotion of Early Warning discovered that early warning systems for drought are more complex than those for other hydro-meteorological hazards and are consequently, relatively less developed globally (ISDR, 2007). Augmenting forecast and early warning information with decision support capabilities to provide information on options for reducing vulnerability to drought enhances local coping capacities and provides an important mechanism for reducing drought risk. Promoting the inclusion of indigenous or local groups and knowledge in drought monitoring and early warning systems is essential for developing appropriate local drought indicators, verifying the occurrence of drought, and communicating the warnings to local populations. Furthermore, although all types of droughts are due to a precipitation deficiency, it is not sufficient to rely exclusively on this climate element to evaluate severity and subsequent impacts because of factors identified previously. Effective DEWS must combine rainfall and other climatic parameters with water information such as stream flow, groundwater levels, reservoir and lake levels, and soil moisture into a comprehensive assessment of present and future drought and water supply conditions. With reference to the case study, in 2009 the Potosí district developed an Early Warning System which provide hydro-meteorological information regarding the probability to have a natural or human induced disaster, which could have impacts on a municipality, a region or the whole district, in order to be able to face such event in an organized and appropriate way.

Such system is based on three levels (FAO Bolivia, 2009). The first level is composed by the institutions that generate information through monitoring points (weather stations or others) that are in various communities in the department. This level includes the National Service of Meteorology and Hydrology (SENAMHI), which monitor the weather conditions of the department. On the second level there is the Departmental Monitoring Centre, which belongs to the Department of early warning system, implemented within the Risk Management Unit of the Prefecture. This unit is responsible for the reception and dissemination of meteorological and hydrological information as well as of disseminated the alert level at the departmental and municipal levels. The third level is made by the users of the System Department of Early Warning System, Municipal Early Warning, communities and those responsible, who are the Prefect of the Department and the Mayor, according to the law 2140, for the activation of operation centres (EOC's) at the Departmental and Municipal level. The developed early warning system has been applied to crop-graze production in various municipalities of the Potosí district and between those even Uyuni and Tomave. Such system combines the expert knowledge with the local knowledge (COMPASUR, 2011). The former bases its assessment on ten weather-monitoring stations, which check: a) weather temperature; b) precipitations; c) wind. Furthermore, through 120 stations widespread in the land dedicated to farm quinoa the susceptibility to wind erosion and the soil humidity are evaluated. Whereas, the latter takes in consideration with reference to a monitoring calendar forty-three bio-indicators divided in three categories: 1) vegetation; 2) animals; 3) climate and stars. Currently, an emergency plan to respond to the EWS alerts is what is lacking.

7. Water and Spatial Planning

Land uses and water have been strongly interconnected in the past but somehow such link has lost its relevance that nowadays water sector and spatial planning are deemed as two domains traditionally separated. The lack of a truly territorial approach in which water and spatial planning could be integrated and considered interdependently has been due to a traditionally sectorial view of hydraulic policies (Valenzuela Montes, 2008) as well as to uncontrolled growth and an unplanned development. Available water resources are menaced by human activities in different forms, such as diffuse agricultural, urban pollutions and over abstraction of groundwater. Hazards related to climate change, which will influence the hydrological cycle of different regions in different countries, may intensify water resource challenges in the future. Hence, a shift towards a planning system based on a proactive approach is necessary (Carter, 2007) not to be only aware of water and correlated problems (environmental, economic and social) but to act in order not to restrict development activities and opportunities in the future. The Bolivian National Developing Programme recognizes the basin river management and the integrated water resource management (IWRM) approach as processes that promote a coordinated development between water, land and related resources to maximize social and economic equity in order to guarantee the sustainability of vital ecosystems (PND, 2009). Notwithstanding such integration has not been

accomplished yet and the IWRM has not been applied yet due to many difficulties. Firstly, a too large scale which does not fit in a region where day-to-day decision-making on water development and management are in the hand of users and communities. Further, local communities do not know and they do not know the modality to express their ideas and concerns when they have to refer to an authority, which is not close to their reality. Thus, it would be necessary a lower scale in order to be able to attract interest of different stakeholders and to manage possible conflicts in the water management. IWRM should not be applied only to river basin management unit, but it should be applied to all different scales (from a village to trans boundary level) cause water stress reveals itself at all levels and needs to be addressed through a combination of bottom-up and top-down measures (Lenton and Muller, 2009). Secondly, a lack of decentralization and cooperation among the different sectors as well as of a fully defined legal framework are at the base of problems in applying such policy. Furthermore, at the national as well as at the local level, policies and solutions are still established to solve punctual or emergency issue lacking thus of a long-term planning vision. With reference to the policy of “Para el Bien Vivir“ (for Living Well), the National Plan for the Integrated Territorial System of the Central-Sur Altiplano (Complejo Territorial Integral de La Region del Altiplano Centro – Sur) developed in 2009 draws a strategic agro-industrial development (MPD, 2009). It is based on the combination of enablement of 1 million hectares of agricultural land for organic production of quinoa to reach a production of 1 million of tons per year, production of compost thanks to lamas’ droppings, tourism activity, petrochemical production and lithium abstraction in the Salar of Uyuni. Such plan do not consider at all the high drought risk which characterized the regions and the impacts of the increasing water demand due to tourism and land use changes as well as the effects of the implementation of a petrochemical and lithium abstraction systems on the aquifer and superficial water. Furthermore, both of investigated municipalities, which will be part of this project, lack of a proper planning system, environmental control system (according to the Environmental Law 1333), stakeholders participation despite of the law 1551/94 (Ley de Participación Popular) which promotes it widely.

9. Conclusions

Climate Change and the high drought risk call for a change in the Bolivian water management. The adoption of the river basin management approach as leading policy marks a relevant step for the future water management in Bolivia and for a more integrated development. Notwithstanding, the selection of a more operative scale would be helpful in the process of participation and decision-making. Indeed, the IWRM should not be considered as a box of reforms and rules but more as a philosophy, which should influence the strategy of projects and programmes instead of being built on them. Furthermore, the high awareness of Bolivian people towards the environmental issue should be valued as a resource to build an integrated system and no as an obstacle to this and to the development. Therefore, more space and chance should be given to local communities to express their ideas and concerns regarding the future development and water management in order to support a

bottom-up approach. Participation could be strength, further, linking sanitation and hygiene sector to IWRM, since such themes claim the attention of people, in particular in developing countries, since they improve enormously the quality of live. Consequently, local initiative should be encouraged by the government in order to invest in a cooperative approach between top-down and bottom up policies. In turn, if on one hand, international development projects in developing countries could represent a valuable tool to favour an improvement in the participation of the communities in the decision making process and in the collaboration among various entities; on the other hand, those projects are characterized by a short-, medium-term plan and are developed mainly in areas where the success rate is higher. Consequently, a shift from a planning and management system based on punctual and emergency interventions to a system based on a more strategic and long-term vision is needed in order to create a room to foster the construction of connections and coordination between the different elements composing the system. In turn, it is not possible to predict in advance that such coordination will be sustainable and equitable but lighter forms of integration (which could be seen as early wins) could constitute the base on which build a higher-level of integration, as in the case of water management and spatial planning. Furthermore, a shift from a reactive approach, which is still widely applied in Bolivia, to a proactive hazard management, is essential in order to cope with future events. According to this, a drought emergency and a communication plans should be developed and linked to the existing early warning system in order that the EWS works at its best and accomplices its functions to warn the population about the risk and to put in place the necessary measures to face the emergency.

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