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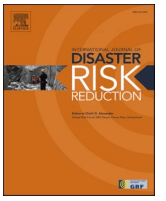

Rice farmers and floods in Ecuador: the strategic role of social capital in disaster risk reduction and livelihood resilience

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ABSTRACT

Social capital plays an essential role in resilience building and disaster risk reduction, as it makes resources available in disaster situations. However, there is still a gap in the literature regarding the relationship between social capital, resilience, and disaster risk reduction. This research aims to understand and explain the role of social capital as a resource mobilizer during times of shock and the potential implications of this for DRR and resilience building. To do so, we develop and apply a framework that integrates the concepts of resilience (specifically the adaptive cycle theory), social capital (in terms of social relationships), and the disaster risk reduction cycle. We apply the framework to the case of rice smallholder farming in flood-prone areas in Ecuador. We find that households' resources are critical to sustaining other dimensions of resilience through different forms of social capital. The availability of resources (canoes, food, water, and others) that households can exchange or share within the community (bonding social capital) sets the conditions for other levels of social capital. Bridging social capital is relevant for accessing temporary refuge for animals, water, food, and loans when resources at the local level become scarcer. The lack of resources creates conditions that strengthen unhealthy social relationships at the bridging social capital level. The use of this framework helped us to systematize our data and provide an overview of how the coping strategies of rice smallholders contribute to and inhibit their resilience during a flood and their transition to recovery.

1. Introduction

Community resilience has become increasingly relevant in research and policy within the context of disaster risk reduction [1]. The development of plans, frameworks, and tools that embrace community resilience as a way of responding to, and recovering from, shock has also increased. In recent years social capital has begun to be explicitly incorporated as a core component in some such developments. However, it is still the case that far less attention is paid to social infrastructure than physical capital. As such, the potential of developing social capital remains underutilized, despite its proven benefits [2,3].

Disasters can destroy all types of capital. Although social capital is typically the least affected [4], it can still be significantly impacted, particularly in ways that influence recovery processes. Social capital is crucial for accessing other capital forms, and no level of investment in physical capital can eliminate risks and vulnerabilities. Social capital, expressed as obligations, networks, and relationships, can transform into economic capital, aiding in securing loans or business opportunities [5]. In families, the presence and educational commitment of caregivers are key structural social capital aspects, that promote children's intellectual growth [6].

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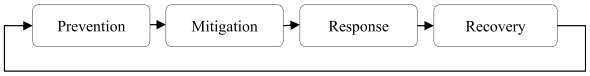

Fig. 1. The DRR cycle (based on *Baas* et al., *2008)*.

Furthermore, community members with shared trust and cohesion often cooperate to share resources and develop infrastructure, both in crises and development opportunities [7].

Strengthening social capital, which strengthens community resilience, is a relevant and complementary approach. Several empirical studies show that social cohesion and social networks are essential in disaster management and increasing local resilience [2,4,8,9]. They show how individual and community social capital networks make resources available in disaster situations; these resources may include information, aid, informal insurance, child care, emotional support, group mobilization, and keeping people from leaving stricken regions [2,10].

The scientific literature linking social capital, resilience, and disaster risk reduction (DRR), can be found in a variety of domains – including economics, sociology, ecology, and disaster studies – and different combinations. Theories and terminologies might differ, but the contexts of their application overlap or are closely related [1,11,12–15]. However, there is still not a comprehensive overview of this tripartite relationship. This research aims to fill this gap by exploring the theoretical and practical links between community resilience and social capital, and their influence on disaster risk reduction.

This research is framed within the context of agricultural livelihoods, households, communities, and natural hazards which together form a dynamic system. The interactions of humans and nature create a socio-ecological system (SES) [16]. Following this logic, in this paper we develop and apply a theoretical framework built on concepts of (a) resilience and the adaptive cycle theory, (b) social capital categorized in terms of interpersonal relationships, and (c) the disaster risk management cycle [12,17–21]. In this paper, we analyze local coping strategies to help us better understand and explain the role of social capital in mobilizing peoples' resources so that they are more able to cope with a shock situation. We also address the influence of the interactions between these different forms of social capital on resilience building and DRR.

2. Development of an integrated conceptual framework

In this section, we outline the relevant theories across different research domains to develop an integrated conceptual framework. In so doing we first summarize different definitions of resilience and DRR. We then explore the convergent complementarities and divergences between resilience and DRR concepts. Finally, we introduce definitions of social capital to build a conceptual model that incorporates these three themes. We then use this integrated conceptual framework to pose and seek to answer specific research questions related to the influence of social capital on resilience and DRR.

2.1. Linking DRR and resilience (through the adaptive cycle of change)

The Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030 prioritizes enhancing the resilience of people and their livelihoods as a disaster risk management strategy: *"Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience"* [21]. This is a clear acknowledgment of the pivotal role of social capital in enhancing resilience and shows the importance of including the development of social capital within risk reduction strategies.

Disaster risk reduction refers to the legal, institutional, administrative, and policy mechanisms and procedures involved in the management of risks and disasters. The DRR cycle includes four phases, see Fig. 1. In the pre-disaster phase, the aim is to strengthen the capacities and resilience of households and communities. The prevention and mitigation of hazards and preparedness actions (to limit the adverse effects of hazards) are required to protect lives, livelihoods, and property. When a shock strikes, disaster response actions take place, with communities and relief agencies focused on saving lives and assets. In the post-disaster phase, the focus is on recovery and rehabilitation. Here, the goal is to move back to normal socio-economic patterns and integrate pre-disaster action aspects into development activities to strengthen resilience and thus better cope with future shocks [20,21].

In a socio-economic system (SES), resilience is defined as the ability of a system to absorb disturbance and reorganize in response to changes and maintain its functions and structures without major deviation from its pathway [15,22]. SESs are always changing, and are considered to be complex adaptive systems. Their adaptive behavior, or resilience, is most often understood and explained by the adaptive cycle of change. This cycle views the system as moving through four phases. In the exploitation or growth phase (r), rapid colonization of recently disturbed areas occurs. In the conservation phase (k) a maximum population is attained, and energy and material accumulation slow down. At the end of the two phases, many resources have been accumulated and the system is vulnerable to disturbances. In the release or 'creative destruction' phase (Ω), these agents cause a sudden release of accumulated resources. In the reorganization phase (α), the system is restructured to minimize losses, and the remaining resources are reorganized to become available for the next exploitation phase. Transitions between phases have been observed, except for direct shifts from the release or reorganization phase to the conservation phase [23].

While the system – ecosystems, agencies, and people – moves through its four phases, its resilience to a crisis is shaped by three dimensions: potential, connectedness, and adaptive capacity. The potential represents the resources or capital accumulated, which determines the number of alternative options for the future. It sets the limits to what is possible. In a social context, this is represented by the accumulated networks of friendship, mutual respect and trust, and institutions of governance. Connectedness is the degree to

Table 1
The adaptive cycle of a system at a glance: phases, dimensions, and definitions (Based on *Gunderson and Holling, 2001)* [17].

Adaptive cycle		Phases			
		Exploitation: Growth and colonization	Conservation: Accumulation/storage of energy/material.	Release: Energy/material release	Reorganization: Restructuring and innovation
Dimensions	Potential or wealth: The options possible for change: 'the available resources'.	Low: resources are slowly accumulated.	High: many resources available for other uses.	Low: triggered by an agent of disturbance; resources decline.	High: leftover resources become available for future developments.
	Connectedness or controllability: The degree to which a system can control its own destiny.	Low: mutually supportive interrelations start and increase.	High: It becomes over-connected and rigidly controlled.	Low: tight organization is lost, feedback regulatory controls are weak	Low: internal regulations are weak.
	Adaptive capacity: The opposite of system vulnerability.	High: starts with the strongest ones (individuals, species).	Low: vulnerable to surprises, accidents waiting to happen	Very low: inherently unpredictable	High: room for experimentation and testing.

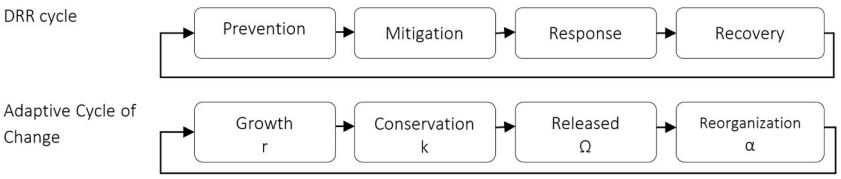

Fig. 2. Linking DRR cycle and Adaptive Cycle of Change.

Table 2
Social capital categorization in terms of household interpersonal relationships.

Social Capital	Household community *a*	Neighboring communities *b*	Individuals/institutions of power *c*
Household *a*	*a*⟷*a* Bonding social capital	*a*⟷*b* Bridging social capital	*a*⟷*c* Linking social capital

Adapted from Sanyal (2016) [9].

which a system can control its own destiny. It reflects the relative strengths of internal control processes and the outside world. When it is high, the behavior of aggregated elements is dominated by inward relations. When it is low, their behavior is dominated by outward relations and affected by outside influences. Adaptive capacity determines a system's vulnerability to unexpected disturbances and surprises that can exceed its connectedness [17,18].

This approach considers adaptive capacity as a dynamic property of a system that works on interdependence with the potential and connectedness dimensions, within a context-specific risk. See Table 1 for a brief description of the expected system's behavior through phases and dimensions.

Disaster risk reduction and the adaptive cycle of change (a lens for studying resilience) are related and complement each other in terms of their actions and chronologies: prevention – growth, mitigation – conservation, response – release, and recovery – reorganization (see Fig. 2). The cycles run within a given scenario of risk, where one of the potential outcomes is that the system maintains its functions despite a shock – by virtue of its resilience. In an agricultural-based livelihood SES, such actions are driven by humans. This highlights the importance of social infrastructure in coping with shocks and recovering from their effects through self-organization. This means, going from a response–release to a growth–prevention stage by drawing on the system's self-organization capabilities.

2.2. Integrating social capital, resilience and DRR

In the disaster response literature, social capital is "defined as resources embedded in social networks and structures, which can be mobilized by individuals. It acts as a resource within the social structure, providing assets for individual action" [4]. This definition aligns with the categorization of social capital in terms of interpersonal relationships, focusing on how social networks and civic institutions contribute to societal well-being [Putnam]. It has become widely accepted in empirical research and is applied in studies of resilience and governance [10,12,14,24,25]. Therefore, this perspective forms the basis for our theoretical choice in operationalizing social capital.

Social capital in terms of interpersonal relationships, distinguishes three categories that are considered to be both a site and outcome, of reciprocity, see Table 2. *Bonding social capital* describes emotionally close individuals, who are tightly connected to a particular group: family, friends, or work colleagues within the same community. *Bridging social capital* emphasizes connections

Table 3
Conceptual framework to explore the role of social capital on Resilience and DRR.

DRR cycle		Prevention	Mitigation	Response	Recovery
Adaptive cycle		Growth	Conservation	Release	Reorganization
Dimensions	Potential		**Social Capital** Bonding – Bridging – Linking		
	Connectedness				
	Adaptive Capacity				

Table 4
Definition matrix that explains the integration of the Adaptive Cycle dimensions during the release phase and the response phase in the DRR cycle.

			DRR cycle
			Response phase
Adaptive cycle	Release phase	Potential	The resources available to people to respond (response phase in DRR) during a shock (release phase in the adaptive cycle theory). In short, this will be referred to as 'available resources'.
		Connectedness	The degree to which people can control their own, and others, response actions and outcomes (response phase in DRR) during a shock (release phase in adaptive cycle theory).
		Adaptive Capacity	The characteristics that limit peoples' vulnerability (brought from the growth and conservation phase in the adaptive cycle theory, and the prevention and mitigation phase in the DRR cycle).

Table 5
Specific research questions to guide the practical application of the conceptual framework.

			Social Capital		
DRR	Adaptive Cycle		Household ***a***	Bonding $a \longleftrightarrow a$	Bridging $a \longleftrightarrow b$
Response phase	Release Phase	Potential	What resources (knowledge, networks, goods, etc.) does a household have to cope with the shock?	How do local networks help households manage or access resources to cope with the shock?	Under what circumstances do social ties with neighboring communities provide resources to complement/ supply local needs?
		Connectedness	To what degree is the household in control of its situation during the shock?	To what extent is the local network capable of providing for the needs of its members before it is influenced or in need of others?	To what extent do these networks dominate/influence/contribute to locals' coping actions?
		Adaptive Capacity	What characteristics influence or shape the household's response to shock?	What are the limits to which the community strategies and resources can respond to a shock? What kind of strategies arise to face the shock when these limits are reached?	What kind of social strategies emerge, that go beyond local networks in seeking to cope with the shock?

between people with different social identities who share common interests or goals: a network of people from different communities or groups. *Linking social capital* defines relationships that cross-group boundaries in a vertical way: a network that connects 'regular' citizens with those with power or influence [9,19,26,27].

Livelihoods and community resilience are useful concepts to introduce into this framework as a way of expressing social capital and its relevance. Livelihood resilience is defined as the capacity of households and communities to sustain their livelihoods across generations despite disturbances [1] whereas community resilience is defined as the collective ability to deal with those disturbances through cooperation [28]. The livelihood and community resilience approaches view people as the main agents settled within dynamic processes of social transformation, whose success at self-organizing depends on their social networks and relationships of trust and reciprocity. In other words, peoples' ability to self-organize is based on their social and cultural capital [15,29].

In livelihood resilience terms, it can be said that a collapse phase (Ω) is an environmental, economic, social, or political disturbance, threatening the continuity of peoples' livelihoods, the resilience of which is defined by people's capacity to self-organize (α phase) across generations to sustain and improve their livelihood opportunities and well-being (from r to k phase) despite those disturbances. Networks of trust and reciprocity constitute people's capital (options for change). Agency and empowerment contribute to people's

Fig. 3. Study area.

governance of hazards (connectedness or controllability). The characteristics of households and communities and their vulnerability, together with their capacities for self-organization and innovation and their knowledge determine their capacity to respond and successfully recover to start a new development stage within the same regime and thus their resilience [1,29,30].

In summary, social capital is essential for self-organization and is essential to effectively respond (response phase in DRR) to a shock (the release phase in the adaptation cycle). In order to operationalize these convergences, the three main components of interest (social capital, resilience, and DRR) can be integrated, as shown in Table 3.

2.3. Developing research questions from the theoretical framework

This research is focused on (i) the specific time frame of a disturbance event, (ii) the stage of response-release, and (iii) bonding and bridging social capital (See Table 4). This study does not include an analysis of linking social capital. This is because the required information is not present in the qualitative data collected by Galarza-Villamar et al. [30], which is the primary source for our research.

In order to apply the framework, we first defined the meaning of the potential, connectedness, and adaptive capacity dimensions, in terms of the release phase of the adaptive cycle and the response phase of the DRR cycle, (see Table 4). Second, we formulated specific research questions about how bonding and bridging social capital might be integrated and formulated within the release-response stages (see Table 5).

As seen in Table 5, the specific research questions guided the data collection and analysis, within the conceptual framework and

Table 6
Summary derived from Galarza-Villamar et al. [30].

Title	Local understanding of disaster risk and livelihood resilience: the case of rice smallholders and floods in Ecuador
Purpose	To better understand livelihood resilience through the theoretical lens of disaster risk management.
Case study	Smallholder households producing rice in flood-prone areas of Guayas Province (in the cantons of Balzar, Nobol, Daule, Palestina, Colimes, and Santa Lucía), within the lower basin of the Guayas River
Methodology	The development and application of a participatory resilience assessment, from a disaster-risk perspective, where users define what is at risk, why it is important, and how should be measured.
Methods	Participatory methods: interviews, focus groups, participatory mapping, drawing, and storytelling through several workshop sessions involving a total of 105 people.
Findings	The use of local metrics resulted in an easy understanding and rapid engagement during the assessment application. Drawings and storytelling helped to reconstruct past events and reveal coping strategies, many of them based on social capital. Systematic identification of household and community strategies that limit or enhance livelihood resilience.

Table 7
Characteristics of smallholders in the study area [31].

Type of farmer	Amount of land	Products	Farm animals	Rice cycles
Subsistence farmer	Less than 1 ha. Located in very low areas.	Main: rice. Secondary: mangoes, bananas, cassava, sweet potato and vegetables	Hens, pigs, and ducks.	Between 0 and 1.
Rice smallholder - monoculture	Between 2 and 5 ha. Located in low areas.	Main: rice. Secondary: mangoes, bananas, cassava, guavas, lemons, oranges, plum, currants, passion fruit, melon, corn, papaya, cocoa and vegetables.	Hens, pigs, ducks, and a horse.	Between 1 and 2 cycles.
Rice smallholder – diversified	Between 2 and 5 ha. located in both high and low areas.	Main: rice, maize, and/or cocoa. Secondary: mangoes, bananas, cassava, guavas, lemons, tamarind, orange, plum, gooseberries, passion fruit, melon, papaya and vegetables.	Cows, chickens, pigs, ducks, and a horse.	Between 1 and 2 cycles of rice and one of maize.

research scope.

3. Methodology: applying the integrated conceptual framework

In this section, We describe how we apply this framework to a specific case study: smallholder households producing rice in flood-prone areas of Guayas Province in the lower basin of the Guayas River, in Ecuador. The purpose of the case study is to explore how useful the framework is in understanding and explaining the role of social capital in mobilizing peoples' resources during a shock.

3.1. Case study background

The data used in this research is part of a qualitative data set gathered by Galarza-Villamar et al. [30] which aimed to develop and apply a participatory risk assessment in order to understand and explain livelihood resilience from a risk perspective. It was carried out in the flood-prone areas of the cantons of Balzar, Nobol, Daule, Palestina, Colimes, and Santa Lucía (see Fig. 3).

The study focused on two distinct flood scenarios: the above-average rainy season of 2012, and the extraordinary event of 1997–1998. These periods were specifically chosen because workshop participants had vivid memories of them. Additionally, this selection is in line with significant meteorological events: the extraordinary El Niño phenomenon in 1998–1999, and the rainy season of 2012 which resulted in the flooding of 184,008 ha in the lower basin of the Guayas River and the Chone River estuary.

The participatory risk assessment was applied through workshops using one sample group in each canton. Each group was made up of 15–25 rice smallholders from different rural communities within the canton, totaling 105 people (for details see [30]).

The emphasis of the participatory risk assessment was on linking participants' individual and collective livelihood resources, both tangible and intangible, with the direct and indirect impacts of flood events, in order to evaluate risk according to their lived experiences, coping strategies, available resources and perceptions. The design of an evaluation tool based on locals' metrics resulted in an easy understanding and rapid engagement during the assessment application. The tool made use of participatory methods, such as interviews, focus groups, drawing, and storytelling, to reconstruct past flood events individually and collectively [30]. It emerged that drawings and storytelling were particularly powerful tools to reconstruct past events and reveal coping strategies that might otherwise have been overlooked and the central role of social capital (See Table 6).

The study found that knowing the local strategies was the key to understanding how people deal with risk by using locally available resources, including intangible resources such as social networking, sense of identity, or reciprocity. The participatory risk approach helped us to systematically identify household and community strategies that limit or enhance livelihood resilience.

The data and research findings of this study are the starting point for the current research, the aim of which is to go one step further: to understand the role of social capital in mobilizing people's resources to cope with a shock. From the qualitative dataset pool, coping strategies that relate social capital to different kinds of resources were selected for analysis. The focus is on the strategies based on different forms of social relationships that households use to mobilize resources to cope with livelihood challenges during periods of flooding. Table 7 shows the general characteristics of farmers within the study area, (for details see [31]).

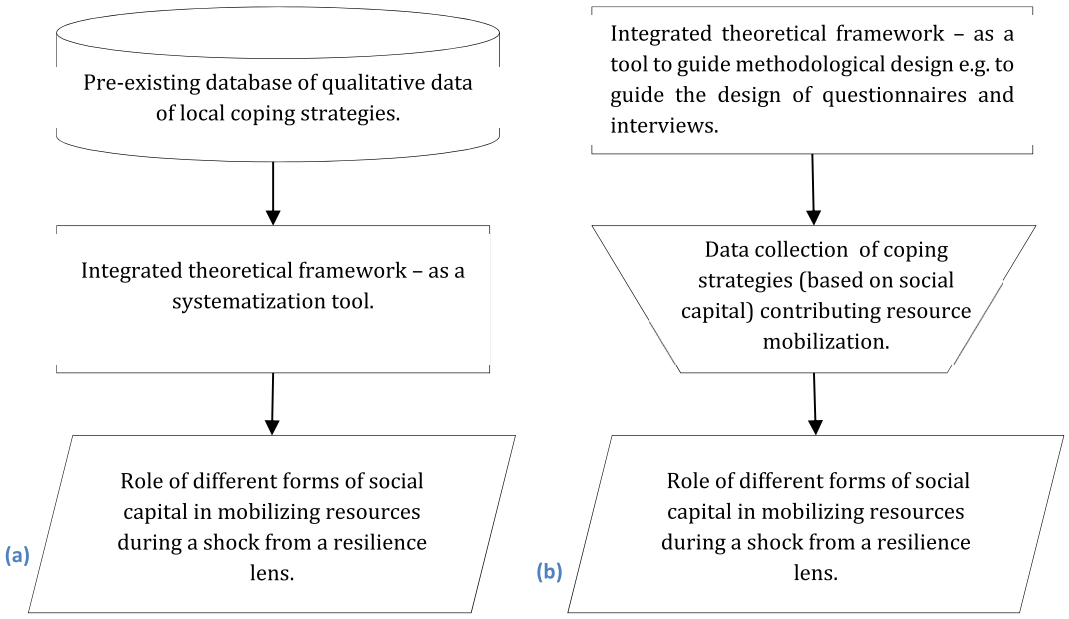

Fig. 4. (a) Application of the framework to analyze an existing database (applied in this research), (b) Application of the framework to guide the methodological design and data collection process (alternative application).

Table 8
Steps followed to apply the framework as a data systematization tool.

Step 1. Make an initial list of coping strategies from the pre-existing databases found in Galarza-Villamar et al. [30]
Step 2. Use the research questions shown in Table 5 to do an initial filtering of the data in terms of the levels of social capital involved in implementing the strategies: i.e. the household and bonding and bridging levels of social capital
Step 3. Match each coping strategy to a livelihood asset: access to food, access to water for domestic use, transportation and spatial connectivity, rice production, and the survival of farm animals.
Step 4. Value each coping strategy's influence on resource mobilization to better cope with the shock (respond) and further reorganization (transition to recovery) as positive (+1) or negative (−1).

Table 9
Examples of coping strategies evaluated as positive (+1) or negative (−1), depending on their influence on peoples' capacity to respond to and recover from flood situations.

	Specific research question	Coping strategy	Analysis	Valuation
Example 1	Under what circumstances do social ties with neighboring communities provide resources to meet/ complement local needs?	Locals request informal loans from several informal lenders (at a high-interest rate) to cover family food needs.	These loans allow the household to access food, but this action reinforces conditions of vulnerability.	The valuation for this action is (−1) because it reinforces vulnerability.
Example 2	How do local networks influence the ways that households manage/access the resources needed to cope with the shock?	Locals exchange food and water based on their reserves.	Exchanging food is an indication of self-organization. This is a positive community attribute to cope with current and future shocks.	The valuation for this action is (+1) because it strengthens coping capacities.

3.2. Framework application

We see that the framework can be used either as a data systematization tool (Fig. 4a) or as a starting point to guide the methodological research design and data collection process (Fig. 4b). Both applications can be used to understand and enhance the role of social capital in resource mobilization when responding to a shock response and making the transition to reorganization (recovery).

We used the conceptual framework to guide a systematic analysis of the available data in terms of its theoretical relevance to resilience, DRR, and social capital, see Fig. 2. This strategy was adopted as we were making use of a pre-existing database of qualitative data. Using the specific research questions set out in 3.2.3, we looked at the coping strategies found in Galarza-Villamar et al. [30] in terms of resource mobilization scenarios for different types of assets, the different stakeholders involved as agents of mobilization, and the characteristics of the situations that the interactions between the two gave rise to. See Table 8.

A valuation of the strategies, as positive (+1) or negative (−1) influence, was done to give a quantitative and descriptive dimension to the analysis. This allowed a simplified visualization of how different coping strategies that are adopted and use different levels of social capital, can have either positive or negative influence on resilience by either enhancing or limiting resource mobilization.

Table 9 shows an example of these positive and negative valuations. These valuations were assessed based on locals' perceptions and narratives of the impact of these strategies on their lives during and after times of flooding.

4. Results

This section describes the results of applying the integrated conceptual framework. The input data are households' and community strategies that were involved in interactions between social capital and resource mobilization to cope with a flood. The results are described within the categories of resources that households need to access or to protect to ensure their survival and the continuity of their livelihoods: food, water, transportation means, rice harvest, and farm animals.

4.1. Access to food

"She (elderly woman) is alone here, but we bring her food and take care of her" (Female, Daule, 2016).

Rice is the main food in the family diet in the study area. Families reserve part of their rice harvest from the dry season to eat during the rainy season and potential flood periods as they know the risks of losing the rice harvest, due to floods or pests, in the rainy season are very high. Fruit trees are also a traditional part of the family farm landscape and are used to supplement the family's diet. During the floods experienced in 1998 and 2012, farmers harvested the fruits as soon as possible, before the trees died, and tried to manually save the rice ready to harvest that was under water.

The harvested rice was dried under the sun, and could only be used for self-consumption due to its high levels of humidity. It was stored in the facilities of rice peeler factories free of charge until they needed it for household consumption. If the water levels were high enough during the flood, some farmers went fishing, while others hunted wild birds to supplement their diet. Floating cane structures were built to house their surviving small farm animals (chickens, ducks, and pigs). Rice, fish, fruits, vegetables, and farm animals were shared and exchanged among neighbors. Yet, the longer the flood lasted, the fewer food resources were available to exchange. Trees died, and as the water level decreased fishing was no longer possible, while the rice reserves were finished in a few weeks.

As households are numerous, their own reserves and exchanged food and food aid supplies could only last a few weeks. Families reduced their meals from 3 to 2 per day, and more active exchanges with neighboring communities took place. Rice peeling factories lent households peeled rice for consumption, which had to be paid back in the next harvest season. This kind of arrangement was not always possible, since it depended on the distance between the farmer and the factory, the relationship between the parties, and the general shortage of rice in the area. Farmers who owned a canoe could go further to look for food and supplies, to commercialize them within the community.

Respondents reported that humanitarian aid from the government and non-profit organizations also contributed to their food supplies during the 2012 flood. Trucks with food supplies would come to the nearest non-flooded communities to distribute the food. The amount of food was based on the number of family members. As few families owned a canoe or were able to get transportation to the supply points, many people used these resources as a market opportunity. People from the flooded area who owned a canoe would seek extra supplies in order to commercialize them. In addition, some families that were not living in the flooded area also claimed to require those supplies. The basic strategy to access more free supplies was to report a higher number of family members or to act in partnership with other families in the vicinity.

Access to a canoe was very important to access food supplies. Canoe owners and their close friends had more opportunities to go to other communities to buy more food for their own families at lower prices. Access to a canoe as an informal public means of transport improved access to food. Unfortunately, even those who could overcome these transportation limitations found that their financial resources were extremely limited, and often needed recourse to informal lenders to finance their purchases. Many respondents reported that borrowing money from informal lenders at high-interest rates (between 10 and 45% per month) was their only solution for buying food, with the capital and interest being repayable after the next harvesting season.

4.2. Access to water for domestic use

During the floods of 1982–1983 and 2012, some people's land was under stagnant water for up to 10 months. Although their homes were surrounded by water, they did not have water for domestic consumption. The available water was either turbid, saline, or contaminated by the collapse of septic tanks and drowned animals. Although most households had a well, most of these collapsed and became filled with sediment, which made them unusable.

During these periods, precipitation was one of the first options to collect clean water. Each household collected rainwater from their roof in buckets. As it did not rain daily, families would quickly run out of water. The next option was to ask for help from friends and neighbors. Some households within the affected communities had wells in slightly higher lands and shared this water, in small quantities, free of charge. Some groups of neighbors were enterprising enough to connect plastic hoses to local pipelines or water wells for common use. These connections were made with the consent of the water source owner and mostly free of charge, due to family ties and friendship.

As water is a daily need, and both the rain and help from neighbors were not sufficient to meet daily demands, informal water markets emerged. If there were no operative wells within the community, some community members who owned motor canoes would get water from neighboring communities, a service for which they charged. The government also intervened, sending water trucks to the nearest non-flooded communities to distribute water to those in need. This involved several family members going to the meeting point with containers to fill and bringing them back home by canoe. The water was distributed according to the number of family members, but many families got more water by lying about the number of members and later sold the surplus water to other families

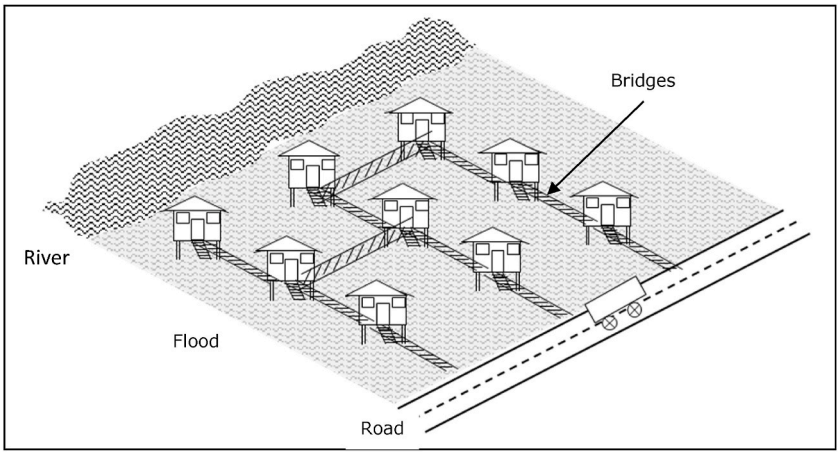

Fig. 5. Houses connected by bridges in order to reach the main road.

who lacked the means to reach the supply point.

Facing environmental and social constraints, many households reported collecting stagnant water for domestic use and storing and decanting this water in tanks before using it. Water for drinking was boiled, but for cooking and personal cleanness was used mostly raw. Many reported experiencing diarrhea and skin conditions as a result of this.

4.3. Transportation and spatial connectivity

"Someone who does not know how to share does not know how to live in this town"(Male, Palestina Canton, 2016).

During the 1980s, it was common for households to have a canoe (either manual or with a motor) which was often one of their most precious belongings. These canoes were the most important means of transporting people and goods as, at that time, there were hardly any roads in the region. The oldest respondents remembered that during the flood of 1982–1983, considered the worst experience in recent living memory, owning a canoe was normal and unexceptional. Some men even considered it essential to own a canoe before marrying: "When I got engaged, I bought two cattle and a canoe before getting married".

By the time of the 1997–1998 floods, few families owned a canoe. Most of them had already sold them (or the motor) after some promises of accessibility and after some roads were built in their communities. The use of motor canoes as a self-organized informal public transport took place in times of floods. As the only way to leave their houses was by canoe, families could either rent a rowing canoe or call a motor canoe to pick them up. By the time of the floods of 2012, motor canoes were even scarcer, and for many people, the only options were to stay at home or to venture out on foot when the water receded to a safe level.

Nowadays, even in areas where annual floods are more the rule than the exception, the tradition of owning a canoe per household has decreased. On average most communities have around three motor canoes that can offer transportation services. The people who offer this service are usually well-known within the community. Transportation by motor canoe is free of charge for the owner's family members, and costs between 0.25 and 0.50 US dollars for neighbors. Those lacking access to a canoe, run the risk of isolation. While some disadvantaged people living in more accessible areas can get help from the canoe operators, it is common for mothers with young children and people with mobility impairments to experience long periods of isolation at home.

Canoes are the most effective way to reach other towns or cities, such as Guayaquil, in times of flood. Living at the river margin is considered an advantage despite its risks. Such a location in combination with owning a canoe is considered a privilege. When ground transportation is not an option, those living inland must ask permission for those living at the river margin to access the river through their properties. This access can be free or involve a small fee depending on the type of social relationship.

A canoe is invaluable in times of flood. It is the main means to transport assets and people. The complementary use of horses and donkeys is also frequent, as cars and motorcycles can easily get trapped in the mud and water. Motorbikes and motor tricycles belonging to those in neighboring communities offer transportation services from non-flooded locations. All these means of transportation belong to a few individuals within or in neighboring communities. As such having social relationships with the operators and owners plays an important role in being able to reach people, places, and assets in times of emergency and scarcity.

Even though most respondents stressed that "everything here is shared. Those who do not know how to live, remain without eating.", yet a few also said that "there is no one to count on". This group of respondents are located closer to the road and none of them own a canoe. People access the road by building cane bridges from one house to the next one in a chain (see Fig. 4). Generally, they do not work together in the bridge construction, but each family builds its own bridge to the next house (see Fig. 5).

4.4. Rice production and credit

"Here we all produce rice, these is what we know how to do" (Male, Santa Lucía canton, 2016).

Farmers' decision-making about whether to crop rice once, twice, or, two and half times a year varies according to a range of factors: one of which is 'the rumour factor'. For smallholders located in highly flood-prone areas close to the river, the decision

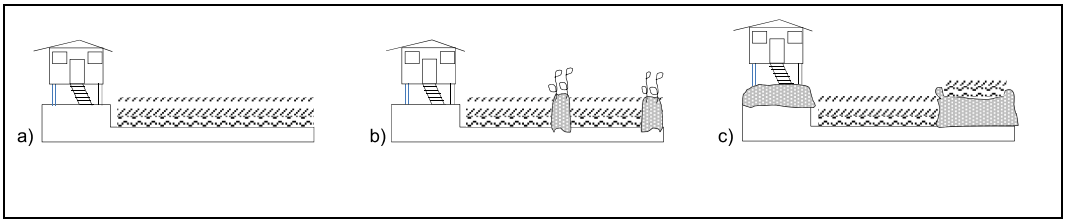

Fig. 6. (a) Traditional rice crops in pools, (b) rice pool walls to crop maize and yucca, (c) ridges to crop rice.

sometimes is taken based on rumors of how the weather is going to behave. Is El Niño coming? Is the rainy season going to be heavy? During the flood of 2012, a year in the region was not affected by El Niño but by heavy rain, many farmers decided to crop during the rainy season. Due to the rumors of a period of heavy rain coming, farmers adopted some of the following strategies to decrease the potential economic losses in case a flood did occur.

- Use of long grain varieties (which means higher investments) during the first cropping season to get higher economic returns, and using short grain varieties during the rainy seasons meant less investment which could be written off if the harvest was lost to flooding.
- Broadcast sewing during the rainy season to reduce costs, and when farmers are able to start a third rice cycle, they use short grain varieties, transplanted to reduce the risk of overturn.
- Farmers with higher land produced seeds to plant them earlier in the lower lands and reduce the length of the cycle term, with the aim of harvesting before any possible flooding.
- Farmers generally invest in certified seed for the first rice cycle of the year but often recycle seed from the first cycle to use in the second cycle to reduce costs (in case of floods).

The phenological stage of the crop at the moment of the flood influences the extent of a farmer's losses and this can vary from farmer to farmer. Respondents explained that if the rice is ready to harvest when it becomes covered by water, they might still be capable of rescuing part of it. Different kinds of self-organized activities take place to do this. A group of neighbors might work together to harvest it manually as quickly as possible. Then the rice is dried under the sun and reserved for self-consumption. If enough farmers have crops ready for harvest they sometimes get together and collectively rent a harvesting truck and operator. For this to work the crops have to be ready to harvest at the same time, which is rarely the case, so collective arrangements for mechanized harvesting are not that common. In addition, during times of flooding, it may be impossible for mechanized harvesters to access the plots, or the land might be too wet for a harvester to be safely used on it.

In spite of reducing investment in rice production and self-organization strategies to harvest rice that is underwater, farmers' economic losses can still be significant. They often need to take out loans to sustain production and meet family needs. Reliance on informal lenders is a common practice: during every cropping season, farmers may borrow between 400 and 1000 dollars per hectare, at interest rates that can be between 10% and 40% per month. The debt must be paid back with the production at the end of each cycle. When production is lost due to floods, informal lenders forgive the interest momentarily, but the capital value must be paid back. When the debt cannot be paid, it increases and must be paid with the production of the next rice cycle. Farmers can easily get trapped in a cycle of indebtedness with one or more informal lenders.

A self-organization response to the indebtedness problem in the area has been the creation of community-saving banks. These saving banks are initially supported by an external institution that contributes seed capital for its foundation. Each member adds a certain amount of money to the seed capital. Every month each member has the right to get a loan for production at a low interest rate. There are few of these initiatives, and those who belong to these groups reported that they do not borrow money from informal lenders anymore or, at least, that they have decreased the amounts and frequency of informal loans. Saving Bank members said that these organizations offer more than just financial support. For example, in the case of the death of a family member, the other members will collect money for the funeral expenses. Farmers from different neighboring communities can belong to the same saving bank, and these community banks may belong to larger farmers' associations.

The social fabric built through the saving banks and other small farmer organizations allows smallholders to access other sources of support: the rice peeling factories. The factories lend money for rice production at lower rates of interest than informal lenders in exchange for paddy rice at the end of the season. In times of flood, the peeling factories allow farmers to store their rice (that has been preserved for family consumption in the previous season), as they do not have dry places to store it. Farmers request their rice from the factory whenever they need some (see section 4.1). Even though these strategies are helpful to farmers in times of crisis, smallholders have limited bargaining power and have to accept the arrangements under which they receive a low price for their rice. Such practices compromise the chances of making a profit out of rice production in the coming season. This can drive farmers to take out new loans from different kinds of lenders in order to cope with family needs and the next production season.

Households' individual conditions are critical at the moment of a flood since they determine the resources that will be available to support the family, share, or exchange. In the case of rice production, the conditions in the area are partly determined by the farm's agricultural diversity. The most common condition is a farming family living on their land, where the main agricultural activity is growing rice. However, there are also farmers who own land on slightly higher lands (and live there) and have small plots of rice production in flood-prone areas. These farmers make higher investments in rice production during the rainy season and can fall back

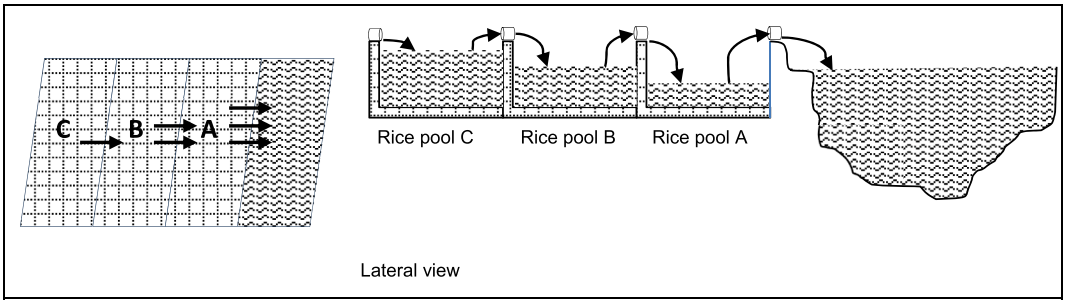

Fig. 7. Rice pools water pumping.

on crops such as maize that they produce on the higher land during the rainy season.

Some farmers practice crop diversification. Rice is planted in pools divided by walls of compacted soil, and some farmers produce yucca and maize on the top of these walls. During times of flood, the rice may be lost, but the maize and yucca survive. Another strategy is to produce rice on ridges during the rainy season as it is more likely to survive the flood. However both these strategies are uncommon (see Fig. 6).

People we spoke to said that in the flood of 1998–1999, the stagnant water sat in the pools for rice production for over 10 months. In 2012, the water remained for around 6 months. Stagnant water presents a problem for starting the next crop season. Farmers developed a self-organization strategy to solve the problem, pumping the water out in a chain. Farmers farthest from the river pumped their stagnant water into the pools below theirs until it got to the pools closest to the river where it was pumped into the river (see Fig. 7). While there is generally a fee charged for pumping water from the river to the pool during the dry season, after a flood this is generally done free of charge.

4.5. The survival of farm animals

"To save your cows, you need good friends in the higher lands"(Male, Balzar canton, 2016).

Most smallholders in the study area have chickens and ducks for self-consumption and keep a few pigs and cows as a source of revenue. Respondents reported that during the floods, most chickens were drowned. In order to protect their animals, some farmers built rafts to house them. As the days went by, the risk of losing the animals to pests or starvation increased. Refrigerated storage of the meat was not possible due to the erratic (or complete lack of) electricity supply. Therefore, the animals had to be quickly consumed or marketed. Many dead animals were just thrown in the water, which became contaminated by their decomposing corpses. The surviving animals were essential as a strategy for accessing other supplies. Families, friends, and neighbors exchanged animals, for food or water. Some farmers sold their animals to traders from neighboring communities who came in canoes and only offered very low prices. Farmers fumed at "*having to sell our chickens for the price of eggs*".

Many households keep a few cows as a traditional form of savings, to be sold when the household has need of ready cash. Their survival depended on finding temporary arrangements to shelter them, to which they had to be moved on foot. Farmers who expected the floods (due to rumors) or who were located in very low areas, sometimes arranged the lease of a non-floodable land in advance. These arrangements were mostly done with friends and family members with land in higher areas for low prices. The fee included shelter and food, as these areas are rich in grass during the rainy seasons. When the floods started, those who had not made a leasing arrangement, or lacked social networks with those in the higher lands, faced difficulties in finding safe shelter for their cows. Cattle rustling is a serious threat when moving cattle and placing them in provisional shelters. In order to improve the probability of having a safe journey, many farmers said that they made the journey with other farmers at the same time.

When the water level receded respondents said that the most feasible way to restart raising farm animals was to take out an informal loan. These are very popular in the area, despite high monthly interests that range between 10 and 45%.

55. Analysis: the role of coping strategies in livelihood resilience

The purpose of integrating the adaptive and DRR cycles and social capital in terms of social relationships was to develop a conceptual tool to analyze the role of social capital in mobilizing resources and enhancing resilience and DRR. To do so, we have analyzed the local strategies of rice smallholders to cope with floods, focusing on the role of social capital in mobilizing key resources needed during the crisis. We applied the integrated framework to five categories of assets: access to food, access to water, transportation, and spatial connectivity, rice production, and the survival of farm animals. By using the framework, we visualized how different forms of social capital interact in resource mobilization across the different dimensions of resilience: potential (P), connectedness (C), and adaptive capacity (AC). These interactions are strategies that can either limit or strengthen livelihood resilience, and we valued each analyzed strategy as either (1) a positive or a negative unit. Fig. 8a and b, shows a summary of the positive and negative interactions that different strategies based on different forms of social capital had for resource mobilization and resilience.

These figures show that local strategies have a mostly positive influence on resilience in the potential dimension. This result shows the coherence of this framework since potential (or people's available resources to respond) represents the resources that need to be mobilized through different levels of social capital to cope with the crisis. The strategies with a positive influence on the potential

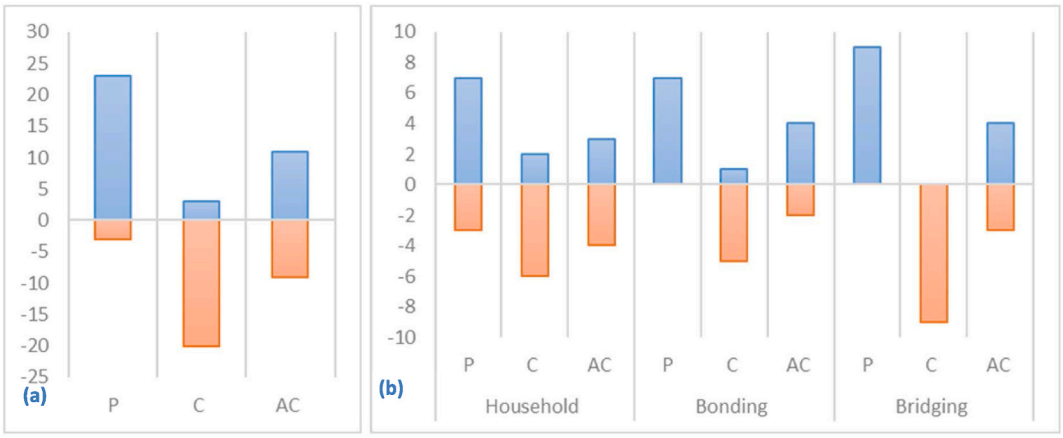

Fig. 8. (a) General balance between positive and negative influence of coping strategies related to different resilience dimensions. (b) The balance between positive and negative influence of coping strategies related to different resilience dimensions (Potential – P, Connectedness – C, and Adaptive Capacity – AC) and forms of social capital.

Table 10
Summary of strategies for access to food that include different forms of social capital across the potential, connectedness, and adaptive capacity dimensions of the adaptive cycle.

Release phase (Ω)	Household *a*	Bonding social capital *a*⟷*a*	Bridging social capital *a*⟷*b*
Potential	(+1) A few rice sacks saved from the dry season. (+1) Harvesting fruits before the trees die. (+1) Harvesting flooded rice that is dried manually and only suitable for self-consumption.	(+1) Fishing within the flooded areas and hunting wild birds are practiced within groups. (+1) Exchanges of rice and fruits/vegetables/fish among neighbors.	(+1) Selling some fish to neighboring communities. (+1) Households get loans of rice sacks from rice peeling factories (+1) Government and NGOs distribute food from non-flooded neighboring communities, mainly during the first months.
Connectedness	(-1) Daily meals are reduced from 3 to 2 per day. (-1) Food supplies from humanitarian aid can be irregular and last only one week.	(-1) Fishing was not possible when the water level fell too low.	(-1) Non-flooded neighboring communities also suffer generalized shortages due to accessibility constraints. (-1) Several members from the same household register as heads of different households to get multiple handouts.
Adaptive capacity	(-1) Households are numerous (around 6 members) and only have enough food to last a few weeks.	(-1) Food exchange became unfeasible as households' food stocks decreased.	(+1) The few farmers that own a canoe lend or rent it to others to buy food in other communities. (-1) Households access loans from informal lenders at high interest rates, or in exchange for a portion of next season's harvest.

Table 11
Strategies to access water for domestic use, including different forms of social capital across the potential, connectedness, and adaptive capacity dimensions of the adaptive cycle.

Release phase (Ω)	Household *a*	Bonding social capital *a*⟷*a*	Bridging social capital *a*⟷*b*
Potential	(+1) Collecting rainwater from the roof for cooking and drinking.	(+1) Friends/neighbors with functioning water wells provide clean water (for free or at a 'fair' price).	(+1) Locals collect water from other communities and transport it by canoe. (+1) The government sent water trucks to provide water from neighboring communities.
Connectedness	(-1) Water is collected from the flooded area, even if it is turbid. (+1) Water is boiled.	(-1) Water supply is limited and farmers buy water from others with a surplus.	(-1) Some farmers (i.e. those with canoes) benefit more and sell the surplus water to others.
Adaptive capacity	(-1) People report suffering from diarrhea and skin conditions.	(+1) Some farmers attach plastic hoses to a neighbor's water pipeline or water well (with permission) for common use.	(No strategy collected)

reflect the availability of resources, such as canoes, food, water, knowledge, skills, labor, and other resources, that different households have to exchange or share. The strategies with a negative influence on the potential refer to practices such as food rationing by reducing the number of meals per day, which reinforces vulnerability conditions (See Table 10).

Table 12
Strategies for "transportation and spatial connectivity" that include different forms of social capital across the potential, connectedness, and adaptive capacity dimensions of the adaptive cycle.

Release phase (Ω)	Household *a*	Bonding social capital *a*⟷*a*	Bridging social capital *a*⟷*b*
Potential	(+1) Some households own a canoe. (-1) Canoes are becoming a less common belonging.	(+1) Families and friends share their canoes without cost. (+1) Canoes can be accessed by other locals for small fees.	(+1) Locals living at the edge of the river can easily reach other communities by canoe through the river.
Connectedness	(-1) Most households decided to sell their canoe after the construction of some roads.	(-1) Households depend on canoe owners to transport people and supplies.	(-1) Locals not living at the river's edge need to cross through the land of those living there. This can be at a cost.
Adaptive capacity	(-1) Some people report experiencing long periods of isolation at home, especially those with mobility impairments and mothers with young children.	(+1) Some neighbors build improvised wooden bridges that connect one house to the next one until they reach a walkable byroad.	(+1) Other transportation means are informally offered from the nearest dry roads: these include horse, donkey, motorbike, or motor tricycle.

Table 13
Strategies for rice production and credit that include different forms of social capital across the potential, connectedness, and adaptive capacity dimensions of the adaptive cycle.

Release phase (Ω)	Household *a*	Bonding social capital *a*⟷*a*	Bridging social capital *a*⟷*b*
Potential	(+1) Use of recycled rice seeds and different seed varieties. (-1) Use of informal loans (at high-interest rates) to finance production.	(+1) If a flood strikes when the rice is ready to harvest, farmers self-organize to manually harvest the crop or rent a harvesting truck when this is feasible.	(+1) Belonging to community saving banks. (+1) Financial relationship with rice peeling factories and other lenders.
Connectedness	(-1) Rice production represents the main or even only income source.	(-1) The harvesting truck cannot always access or work the land. (-1) Harvesting time is not uniform.	(-1) Price fluctuations. (-1) Low bargaining power.
Adaptive capacity	(+1)Farmers with land in high and low areas, crop tomato and maize in the high lands and rice (with low investment) in the low lands during the rainy season. (+1)Yucca and maize are planted in some rice pool walls, around the houses, and at the edge of drainage channels as a source of food/ income during floods.	(+1) Pumping water out of rice pools is done through neighbors' informal self-organization free of charge.	(+1) If the harvest is lost, informal lenders tend to forgive the debt's interest and wait for payment of the capital until the next harvesting season. (-1) Farmers get trapped in an indebtedness cycle. (+1) Rice peeling factories make rice 'loans for domestic consumption.

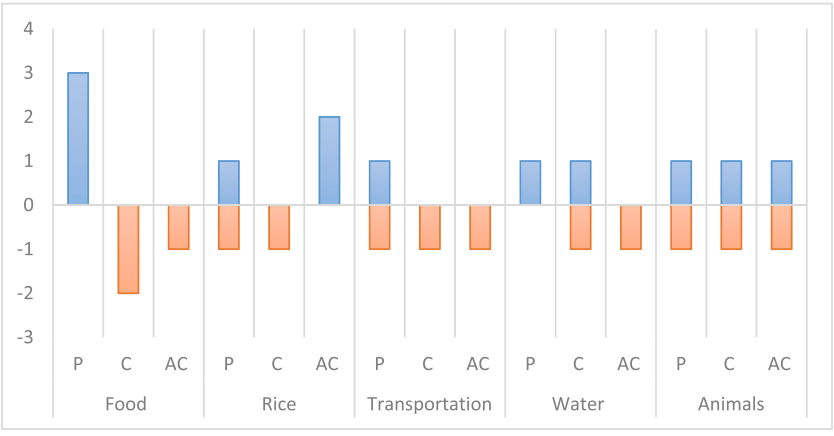

Fig. 9. Coping strategies at the household level on the access to different livelihood assets.

Conversely, coping strategies reveal mostly a negative connectedness. As connectedness refers to the degree to which people can control their and others' response actions and outcomes during a shock, this result indicates mostly low levels of local control. Why is locals' response control limited? Based on the analysis of the qualitative data, we see that because resources are scarce, they are not sufficient to see people through a prolonged flood, which can last several months. Therefore, sooner than later, locals' responses heavily rely on external support. This negative influence is more evident in the bridging social capital, because as scarcity and need create breeding grounds for unhealthy social relationships such as, for example, the expensive commercialization or unfair distribution

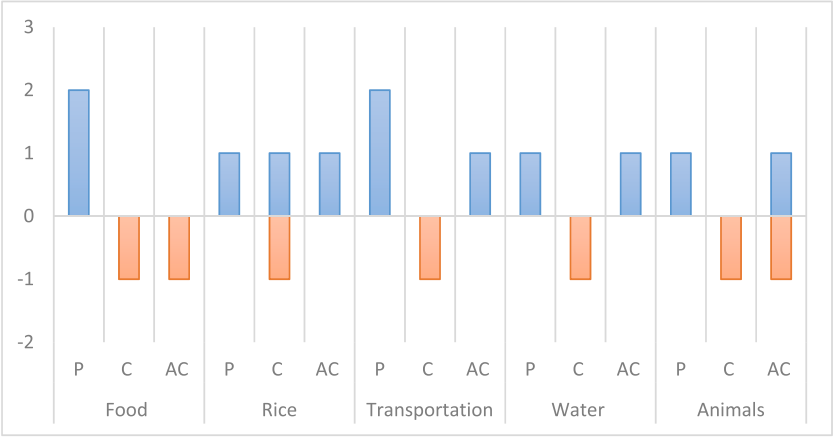

Fig. 10. Coping strategies at the bonding social capital level on the access to different livelihood assets.

of water (See Table 11).

The coping strategies reveal an almost equal mixture of positive and negative aspects of the adaptive capacity dimension. This is because the same strategies that are used to adapt to an adverse situation, can reinforce conditions of vulnerability that last longer than the flood. For example, to cope with a money shortage, households take out loans from informal borrowers, at a high interest rate, agreeing to pay the debt with the next rice harvest. While this strategy brings an immediate solution to the cash shortage, it reinforces a consistent cycle of indebtedness (see Tables 10 and 13).

5.1. The household level

As part of this study, we added the household level of social capital. The purpose was to explore the resources, conditions, and strategies available at the smallest social unit of the community (households) that define the resources, conditions, and strategies available for the other levels of social capital (bonding and bridging). Fig. 9 summarizes the results in terms of each asset considered and the resilience dimensions (potential, connectedness, and adaptive capacity).

The resources available at the household level set the conditions in which the strategies of sharing or exchanging resources through bonding social capital can take place. What households have is what creates a pool of resources for the community for cooperative strategies? For example, the practice of keeping aside sacks of rice during the dry season and harvesting fruits before trees die due to the flood provides options for food exchange among neighbors. In the case of water for domestic consumption, if some households preserve their wells in working condition, they can provide water to other households whose wells have collapsed or been contaminated. To ensure animal survival, household skills in building rafts to prevent chickens and pigs from drowning can be the basis for securing sources of food or other resources that they are lacking.

Although there is generally a diversity of resources at the household level, in general, they are limited in both quantity and quality. While households can prevent animals from drowning by building rafts, the animals may die from hunger and pests a few weeks after the flood starts. The lack of electricity, and therefore of working refrigerators, make it unfeasible to preserve their meat. Therefore the animals' meat needs to be consumed or sold (very cheaply) before, whilst it is still fit to eat. At the same time, families are numerous, and those with fewer reserves and or more family members will run out of reserves sooner. In the case of transportation, few households now own canoes, which are the only suitable transportation means during a flood. All these constraints lead to a situation where individual households have limited control over their response to shocks.

The initial conditions of vulnerability, such as poverty, poor health among household members, or having few resources to participate in sharing and exchanging practices, are critical. Because families are numerous and financial hardship is widespread in the area (communities are largely reliant on rice monoculture, which can be lost during a flood), we can see that no strategies have a positive influence on connectedness nor adaptive capacity in terms of accessing food. On the other hand, creativity in designing coping strategies with available resources and the willingness to implement them are also important. In the case of rice production, we found that diversification, by producing maize and yucca (on the borders of the rice production pools) or producing rice on ridges during the rainy season (see Fig. 6), positively influenced household adaptive capacity.

5.2. The role of social bonding capital

In Fig. 10, we can see that bonding social capital (based on local networks) has an important positive contribution to adaptive capacity for all assets. During a flood period, it is unfeasible that a household is self-sufficient, therefore local networks play a critical role in creating a diverse pool of resources to meet the needs of the community. Access to food and transportation are the most reliant on bonding social capital, especially during the first weeks of the flood period. Yet we also observe that these strategies have a negative influence on connectedness for all types of access since all these resources are scarce at the local level.

Although local networks have an important role, their capacity to provide solutions is limited by the generalized vulnerability at the local level. Food is the resource most affected, and the community might only manage to be self-reliant for a few weeks or months

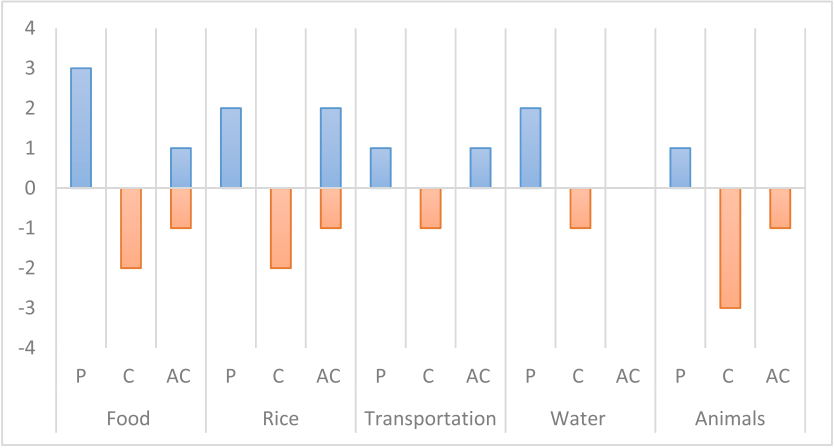

Fig. 11. Coping strategies at the bridging social capital level on the access to different livelihood assets.

even if they employ sharing mechanisms. In the case of rice production, farmers organizing themselves to pump water out of the rice production pools contributes to livelihood resilience, since this allows farmers to restart their productive activities sooner (see Fig. 7). However, although these self-organization activities improve farmer's prospects, their capacity to restart agriculture is limited by the lack of other inputs. In order to cope with flooding, households, and the community as a whole, need to rely on broader social support networks.

5.3. The role of bridging social capital

As the resources that can be mobilized through the bonding social capital level are limited, the affected communities need to create networks with external individuals and institutions that have more power to make the lacking resources accessible or available. In other words, they need to rely on bridging social capital strategies. Fig. 11 shows the positive and negative influences of bridging social capital in terms of the five analyzed assets. On the one hand, bridging social capital can have a positive influence as it allows households to access the resources they lack, such as cash, water, or food. On the other hand, the negative influence is linked to the often unfair conditions under which this access takes place, such as high-interest rates, low prices paid for animals, or high prices for buying water.

Ensuring the survival of animals through bridging social capital strategies has the highest amount of negative effects on adaptive capacity. Communities affected by the flood have limited options to commercialize their animals before they succumb to hunger or disease. As a consequence, outsiders buy their animals, mainly small animals such as pigs and chickens, at low prices. An opposite example is a case of ensuring the survival of cows. In this case, long-lasting networks between farmers in lowlands and higher lands often make it possible to find a safe place to keep the cows until the flood recedes.

Strategies at the level of bridging social capital, as at the other levels, are also limited by the quantity and quality of available resources. However, in this case, they are also limited by opportunistic behavior that strengthens unhealthy social practices, such as inequality, unfairness, corruption, and opportunism. The limits of bridging social capital strategies also lead us to consider the importance of linking the different social capital strategies. Although linking social capital is not considered in this study, the results lead us to reflect on the lack of regulations and effective flood disaster risk management plans in the area.

6. Discussion and conclusions

This paper has sought to systematically present the development and application of a framework that integrates concepts of (a) resilience and the adaptive cycle theory, (b) social capital, in terms of social relationships, and (c) the disaster risk management cycle. The reason for developing this framework with these specific concepts was to explore the role of social capital as a way of mobilizing resources during a socio-ecological shock.

6.1. The central role of social infrastructure in mobilizing resources

One of the main messages of this research is that, while we cannot deny that all types of resources are important, social infrastructure plays a central role in mobilizing them. The use of the framework makes evident the importance of households having access to some initial basic resources (such as reserves of food or water, or a canoe) in order to be able to participate in networks of support and cooperation. It also makes explicit that different forms of social relationships have both positive and negative influences on the use, protection, or distribution of those resources during a shock event.

A lack of resources creates more opportunities for unhealthy social relationships within the same or neighboring communities since it decreases the bargaining power of households lacking resources. Some examples are financial dependency on informal lenders (Tables 10 and 13) or unequal accessibility to formal aid distribution channels (Table 11). On the other hand, the availability and diversity of resources at the household level allow space for developing healthy social interactions. Some examples are the practices of

Table 14
Strategies for "farm animals' survival" that include different forms of social capital across the potential, connectedness, and adaptive capacity dimensions of the adaptive cycle.

Release phase (Ω)	Household *a*	Bonding social capital *a⟷a*	Bridging social capital *a⟷b*
Potential	(+1) Cows tend to survive and can be walked to higher lands. (-1) Chickens and pigs die from drowning, pests, or lack of food.	(+1) Surviving animals are shared and exchanged among family, friends, and neighbors.	(+1) Locals have friends and family in higher lands that rent them a place to house their cows.
Connectedness	(+1) Homemade rafts are built to house surviving chickens and pigs. (-1) Dead animals are thrown into the stagnant water causing its contamination.	(-1) The exchange of chickens and food is limited as the number of animals and conservation means are both limited.	(-1) Chickens and pigs are sold for very low prices. (-1) Places to allocate cows can be limited. (-1) Cows can be stolen by rustlers on their way to higher grounds.
Adaptive capacity	(-1) Farmers must wait until the water recedes before raising animals again. (+1) Cows come back to the farm after the flood.	(-1) Generalized shortage of farm animals. (+1) Farmers self-organize to bring back cows to their farms.	(-1) Informal loans are needed to restart animal raising.

sharing or exchanging food, water, labor, or access to transport in a synergic way to cope with shortages (Tables 10 and 11).

6.2. *The practical value of acknowledging social capital as a key resource mobilizer*

We consider that the added value of the framework we have developed relies on the practical use that policymakers and practitioners can make of it. One of the strengths of using the framework as a lens to relate social capital to resource mobilization is that it a clearer picture of how specific resources (food, water, transportation, among others) are coupled in practice with different forms of social capital. This information can be valuable when designing and implementing more targeted mechanisms to support resilience-building and DRR practices at the local level.

To exemplify this, we draw on data from the findings relating to the strategy of accessing food (see Table 10). One of the strategies considered to be positive was neighbors exchanging rice for fruits/vegetables. Smallholders' reserves of rice allowed them to access other types of foods through mechanisms of cooperation and reciprocity. The more diverse (fruits, vegetables, chickens) households' livelihoods were, the more resources they had to consume or exchange. This insight could be valuable for policymakers and encourage them to design mechanisms to support livelihood diversification. As such, diversification is not only relevant for food security or biodiversity but also for disaster risk preparedness and resilience. Within the same example, a strategy considered as negative was when several members from the same family registered as a head of a household to get more benefits from government aid than their neighbors. A deeper knowledge of how this practice takes place during a crisis in the area could help practitioners to adjust the logistics for aid distribution.

6.3. *The usefulness of the framework in exploring the role of social capital in other stages*

The systematic and coherent integration of concepts has allowed us to dissect general coping strategies into more specific 'social infrastructure – resource mobilization' relationships (see Tables 10–14). Although this research applies the framework within (i) the specific time frame of a disturbance event, (ii) the stage of response-release, and (iii) bonding and bridging social capital, it could be potentially applied far more widely. We consider that this framework could also be used to explore the role of social capital for resource mobilization at other stages. For example to explore the role of bonding and bridging social capital during a mitigation-conservation stage (before a shock).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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