Disrupting urban ‘risk traps’: bridging finance and knowledge for climate resilient infrastructural planning in Lima, Peru

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Key Messages
• Everyday risks, like those generated by lack of access to water and sanitation, and small scale episodic disasters, such as rock-fall, landslides and building collapse, are exacerbated by climate change effects and recurring climatic events like El Niño.
• These everyday risks and small scale disasters affect the most vulnerable segments of the population and contribute to the reproduction of urban risk traps in the centre and the periphery of the city.
• Despite the negative and long-lasting consequences of these risk accumulation cycles, official maps focus on the potential impacts of large scale disasters caused by natural events of short duration, thereby rendering invisible the quotidian risks experienced by the most disadvantage women and men.
• This invisibility means that the vicious cycles of everyday risk accumulation are not targeted by state-led actions to assess, reduce and prevent risk, which in turn limits the design and implementation of effective and just urban planning tools and public investments.
• Mapping can be a powerful means to apprehend different types of risk, their causes and distribution, therefore offering a comprehensive spatial understanding of how these risks are produced and reproduced over time, where and with what consequences.
• cLIMA sin Riesgo adopts a participatory mapping methodology that includes those women and men most potentially affected by everyday risks, thereby strengthening local capacities to disrupt the vicious cycles of risk accumulation they face in Lima and many other cities in the global south.

INTERROGATING CONVENTIONAL RISK MAPPING
Official risk maps play a key role in urban planning as well as in the design and implementation of policies. These maps are produced and used by public and private actors to evaluate the spatial distribution of impacts, define policies and programmes, as well as formulate actions for risk mitigation and/or prevention, which also influence the allocation of public funds. For instance, the Peruvian National System of Public Investment (Sistema Nacional de Inversión Pública - SNIP) requires the evaluation and mapping of risk as a prerequisite to consider Public Investment Projects (PIP). Acknowledging that risk maps influence decision making, it is important to interrogate what they capture, what they exclude and with what consequences.

In Lima, like in many other cities, the mapping of risk is based on technical and scientific studies focusing on the assessment of urban resilience and/or fragility in the face of intensive disasters caused by natural events of short duration and high impact, such as earthquakes. Although this approach offers valuable information, it does not make visible the accumulation of extensive or small scale risks, and the resultant reproduction of urban ‘risk traps’ exacerbated by climate change effects and recurring climatic events like El Niño.

Urban risk traps affect the everyday life of a large number of highly vulnerable citizens, hindering their right to the city. The omission of everyday risks and episodic disasters in official maps prevents the spatial understanding and identification of where, how, who and why people live at risk in the city, thereby limiting the design and implementation of integrated and participatory solutions for risk management and spatial planning.

CLIMA sin Riesgo integrates a spatial and social outlook to identify how risk is distributed, where it accumulates and with what consequences for the most vulnerable women, men and children who live in the centre and the periphery of Lima. As we search for new approaches and proposals, this document builds upon Policy Brief N° 1 entitled “Urban risk: In search of new perspectives” (Allen et al., 2015) offering an innovative mapping methodology to overcome commonly found limitations in conventional risk mapping and to enable the identification and assessment of urban risk traps (Fig. 1).

Figure 1: Participatory mapping process in José Carlos Mariátegui, San Juan de Lurigancho

Source: cLIMA sin Riesgo, DPU-UCL
1. MAPPING RISK: NEW PERSPECTIVES

In July 2015, cLIMA sin Riesgo met with several public entities who work on disaster risk management, preservation of cultural heritage, urban regeneration, infrastructural service provision, urban development planning and land use zoning. The objective was to contrast and evaluate the different methodologies adopted to map risk. The discussion revealed that everyday risks and episodic disasters (Fig. 2) are often disregarded, while most institutions define risk management strategies, relying on sectoral statistics and often outdated and non-georeferenced data. This approach limits a comprehensive understanding of the spatial distribution of risk and its accumulation over time, therefore hindering the design of effective structural solutions.

Institutions and their competencies

In Peru, the Law 29,664 establishes that disaster risk management is under the competence of the local government (at the metropolitan and district level), as well as regional governments. These authorities are in charge of implementing integrated actions in different jurisdictions. The National Centre for the Estimation, Prevention and Reduction of Disaster Risk (CENEPRED) and the National Institute of Civil Defence (INDECI) support and promote the implementation of policies, instruments and norms related to seven steps in disaster risk management: assessment, prevention, reduction and reconstruction (under CENEPRED’s responsibility), and preparedness, response and rehabilitation (under INDECI’s guidelines). These steps include the elaboration of risk maps. In practice, however, most institutions adopt a reactive approach to risk management and mapping, by focusing mainly on emergency situations brought about by large scale natural events. This approach limits prospective risk management, which should include the spatial understanding, evaluation and monitoring of those everyday and episodic threats faced by the most vulnerable groups in the city.

Public institutions coincide in their use of scientific studies and the prediction of large scale disasters as principal tools to identify and visualise risk on official maps. However, this approach overlooks the potential of knowledge co-production through participatory mapping processes in the identification of small scale hazards and their accumulation over time, thus hindering a prospective approach to risk management and prevention. Moreover, the different institutions that map risk work in a fragmented and dispersed way, which poses a further obstacle to this approach. For example, the mapping of respiratory diseases and tuberculosis, which are the principal ailments in Metropolitan Lima, are monitored and mapped by the Ministry of Health (MINSA). The documentation and mapping of extreme poverty and vulnerability falls under the responsibilities of the Ministry for Development and Social Inclusion (MIDIS). A sectoral approach to interrelated risks results in partial solutions and responses to risk management. The approach adopted by cLIMA sin Riesgo to mapping risk opens new opportunities to overcome these limitations by producing spatial information, at different scales, together with the inhabitants that are under threat and/or most affected. This enables the design of integrated responses and coordinated investments and actions across state authorities and local communities.

Methodologies

Various ministries and municipalities map risk through the following process: (i) collection and identification of key variables; (ii) elaboration of physical vulnerability maps; (iii) analysis of hazards and hazard mapping; (iv) analysis and evaluation of infrastructure and services potentially impacted; (v) definition of vulnerability maps and (vi) analysis of disaster risk and production of synthesis maps (MML, 2015).

CENEPRED promotes risk assessment though four processes: (i) definition of hazard levels, (ii) vulnerability analysis, (iii) risk calculation and (iv) definition of measures to control risk (CENEPRED, 2015) (Fig. 3).

Expert knowledge

Official risk mapping is led by specialised technicians without the engagement of the population. This top down perspective ought to be challenged, as people’s experience of local problems should also be considered expert knowledge. It is therefore important to ensure their participation in all stages of mapping, from the design of the methodology to data collection, throughout its analysis and interpretation, and ultimately the co-design of preventive solutions (Fig. 4).

The articulation of different types of knowledge throughout the mapping process can offer a more precise and comprehensive spatial and social diagnosis. Moreover, mapping can promote dialogue and negotiation in decision making among different stakeholders, and contribute to the design of specific solutions to effectively disrupt urban risk traps (Fig. 5).

Collective decision about what to map and why

Mapping everyday risks, which are often made invisible, requires an in-depth spatial understanding of the social, environmental and economic conditions involved.

Figure 2: Everyday risks and small scale episodic disasters (such as fires, due to exposed electric wires in Barrios Altos, and the collapse of retaining walls in José Carlos Mariátegui), might be exacerbated by climate change effects, such as more intense or frequent rainfall.
that can explain the unequal distribution of threats and vulnerabilities in different areas of the city.

An engagement with different contexts calls for a participatory methodology to identify what to map, how and at what scale (Fig. 6).

**Multi-scalar mapping**

To support a proactive approach to risk management and prevention, mapping ought to be undertaken at various scales. The methodology for risk estimation adopted by state institutions aims to consider two scales: a micro scale for the identification and micro-zoning of risk; and a macro scale, to determine risk scenarios. However, in the absence of primary information, the majority of these maps focus on the macro scale, thereby perpetuating the invisibility of everyday risk and episodic disasters and vulnerabilities that can only be observed at a finer scale. A different understanding can be attained when focusing simultaneously on the household scale, the urban block and the neighbourhood scales. Contrasting information at these various scales and at the city level enables not only the spatial assessment of different threats and vulnerabilities but also of diverse capacities for action among those potentially affected and those responsible for managing and preventing risk (Fig. 7 and Fig. 8).

**Mapping investments**

The calculation of risk adopted by government agencies includes the estimation of potential harm or harmful effects in a defined area - that is the quantification of potential material losses and damages to properties, services and...
facilities, and injury or loss of human life - as well as recommended measures for preventive control and risk reduction. Risk assessment ought to include the costs generated by large scale disasters and also the accumulation of extensive risk over time, such as localised floods and mudslides that occur more frequently due to climate related changes that intensify rainfall. Moreover, it is necessary to take into account the social and spatial distribution of risk on a given area, as well as the investments made by ordinary citizens and public agencies alike to cope and mitigate risk. This perspective shift can improve the coordination of state-led projects and investments, which might not always contribute to risk reduction and paradoxically create and/or displace risk to other groups or parts of the city. For instance, there are various municipal programmes that have consisted in ameliorating or building new stairs in occupied areas located in steep slopes. Although, on the one hand, this improves the access for communities living in these areas deemed of high risk, it promotes further expansion on the upper parts of the slope. Furthermore as the design and construction of staircases do not always meet safety criteria, accidental falls may increase. This negative collateral effects often represent a loss of public resources and might even deepen and expand the impacts and vulnerability experienced by a large number of urban dwellers living in informal or marginalised areas (Fig. 9). The mapping methodology adopted by cLIMA sin Riesgo allows identifying public and community investments made at the city and neighbourhood level, as well as those costs incurred by individual households to cope with or mitigate risk. This in turn enables the assessment of how much is invested, by whom, with what purpose and effect. Furthermore, this methodological approach helps to identify who is more resilient or vulnerable to different types of urban risks and where, and to co-define strategies to maximise the potential positive impact of investments made on the area (Fig. 10).

2. WHERE IS THIS METHODOLOGY APPLIED?
cLIMA sin Riesgo has applied its mapping methodology in two contrasting areas of Metropolitan Lima: Barrios Altos in the historic centre (Cercado de Lima) and José Carlos Mariátegui in the periphery of Lima (San Juan de Lurigancho) (Fig. 11). Both areas, occupied by vulnerable and marginalised social groups, are exposed to a wide range of threats as part of their everyday experience. In addition, each area have been mapped according to different perspectives (Boxes 1 and 2).

3. HOW IS THE METHODOLOGY APPLIED?
The participatory action-research methodology developed by cLIMA sin Riesgo involves the mapping of everyday risk and episodic disasters together with those who are vulnerable and exposed to them. Mapping aims to systematically capture where these risks manifest, who is affected by them and with what consequences. This requires the adoption of various innovative mapping tools, all of which are open source, easy to access and use, and enable the visualisation of findings during the various phases of the process (Fig. 15).
Box 1: THE CENTRE
BARRIOS ALTOS
Over time, the city centre has been repeatedly mapped from different perspectives. Existing thematic maps produced by government agencies depict Barrios Altos as a poor and insecure zone, overcrowded, with high criminality and in risk of physical collapse (Fig. 12). These maps principally take into account the construction materials of the buildings and the probability of their collapse in the event of an earthquake, but do not consider the daily risks that threaten the most vulnerable segments of the local population, such as fires or spread of epidemics due to lack of water and sanitation, thereby limiting the scope of urban renovation projects and programmes in the area.

Box 2: THE PERIPHERY
JOSE CARLOS MARIATEGUI
The periphery of the city undergoes dynamic changes but, in contrast with Barrios Altos, it is under-mapped, with few and often outdated maps produced by municipal authorities and Civil Defence. These maps only capture partially the risks that threaten the area and exclude the settlements emerging through the never-ending occupation of the steep slopes that border the city (Fig. 13). As the residents consolidate these settlements under precarious physical and legal conditions, they are often excluded from public plans and investments to improve housing, basic services and social facilities, thereby exacerbating the vulnerability of those living in these areas.

In order to gain official recognition, local community organisations hire professional topographers to produce schematic plans of their own settlements. These plans or maps exclude contour lines and represent the terrain as flat, therefore failing to record the risks associated with the occupation of the steep slopes (Fig. 14). These plans are also used by community organisations to subdivide plots further up slope. In the absence of public recognition and investments, the selling of new plots carved out of the slopes is often regarded as the only viable financial source to improve the liveability of the most consolidated parts of the settlement. In short, these abstract plans do not reflect the challenges associated with the continuously mounting risks produced by urbanisation in this area.

Figure 13: Risk map, Civil Defence, SJL-MML
Source: INDECI-SJL (Rita Lambert PhD research)

Figure 14: Drawing of allotments and subdivisions
Source: INDECI-SJL, DPU-UCL
Step 1: Identification of specific risks relevant to each context

To integrate the knowledge and experience of those directly exposed to everyday risks, the mapping process begins with transect walks led by community leaders to identify and reflect upon the specific risks that affect each area (Fig. 16).

This knowledge complements scientific and sectoral studies, determining with more precision the location of physical threats and revealing other sources of risk and vulnerabilities. Moreover, it allows an understanding of the inhabitants’ perception of risk and the identification of the capacities required to respond to these risks effectively and preventively.

In the two case studies, the transect walks unearthed diverse aspects which are often invisible in scientific studies. For instance, in José Carlos Mariátegui local dwellers engage in communal work also known as ‘faenas comunales’ and collectively invest to improve roads, infrastructure and basic services, as well as to mitigate conditions of risk in the area where they live. In parallel, the neighbours that inhabit the higher parts of the slope frequently make individual investments to protect themselves from the consequences of repeat weather events such as mud slides.

Paradoxically, many of these actions and investments result in the aggravation of existing hazards and the generation of new ones such us collapse of retaining walls and rockfalls. Risk is further exacerbated by land traffickers, who operate in the higher parts of the hill slope, thereby contributing to the endless urbanisation of the periphery in a way that increases risk.

In Barrios Altos, the situation is equally complex, as the housing units are occupied by multiple families. Here, collective investments to mitigate risk depend on the level of local social organisation and cohesion at the scale of the multi-family housing unit. This means that when mapping risk, it is equally important to consider physical-environmental and social aspects, as well as local capacities for action. The latter are affected by various factors such as the legal status of property ownership and tenancy.

In synthesis, a participatory diagnosis of threats, vulnerabilities and capacity to act enables the understanding of how risk is internalised and externalised at different scales.

Step 2: Preparation of a digital cartographic platform

In order to gain a detailed understanding of everyday risk, it is important to use cartographic bases that offer accurate information at the level of the area, settlement or neighbourhood, urban block, plot, and individual household. With regards to the centre of Lima, the Cadastral Institute of Lima (ICL-MML) provides information at block and plot level, but not at a scale that shows the subdivision of properties into individual dwellings. Therefore, other maps - such as those produced by the public water and sanitation company SEDAPAL that record individual infrastructural connections - can be used to identify subdivisions of multi-family housing units and the number of tenant households that occupy each unit. In addition, in areas that experience rapid change, the production of up-to-date high resolution aerial images constitutes an essential resource to guide the collection of further data in the field.

clIMA sin Riesgo uses high resolution two and three dimensional images, produced with the help of drones(10) (Fig. 17), during the action-research project ReMap Lima [www.remaplima.blogspot.co.uk]. These images capture a level of detail that satellite images do not offer, allowing an accurate identification of current land and housing subdivisions, use and occupation.

Furthermore, the images are accessible and easy to understand, offering recognisable landmarks and reference points. This makes them invaluable resources throughout the whole participatory mapping process, enabling community mappers to identify the location of particular threats, their causes and manifestations, and also of the investments and actions undertaken to mitigate risk. Such actions include the passive occupation, which consists in greening areas higher up the slope to halt further occupation and reduce the risk of rock falls, and also the installation of fog catchers for water harvesting.

Step 3: Design of georeferenced surveys

Generally, survey questionnaires are created by specialists and manually filled in. In clIMA sin Riesgo, there is a strong focus on the inclusion of local dwellers in the design of the questionnaires and the use of smart phones and free surveying tools.

Figure 16: Transect walk guided by community leaders sharing their living conditions and context.
Box 3: Survey selection process

In the case of José Carlos Mariátegui, the survey was applied to 11 settlements situated in 3 valleys which join at a main road. While some of the surveyed settlements are located uphill and undergoing rapid expansion, others are more consolidated areas at the foot of the slopes. At the household level, the survey covered 30% of the occupied plots in each settlement, reaching 350 households living under different levels of exposure and vulnerability to risk.

In Barrios Altos, a sample area of 40 urban blocks were included in the survey, within which a further sample of 30% multi-family housing units (200 units) occupied by a large number of tenant households living under different levels of legal and physical insecurity were interviewed. The sample included: 1. Multi-family housing units declared uninhabitable by the Municipality; 2. Multi-family housing units in overcrowded and deteriorating conditions, declared as ‘tuğurios’; 3. Multi-family housing units declared as historic patrimony; 4. Multi-family housing units targeted by municipal programmes; 5. A random selection of housing units was surveyed to cover the remaining 30% in each urban block.

Following this methodology, the project has undertaken 700 surveys with the most disadvantaged inhabitants of the centre and the periphery of Lima (Box 3).

**Step 4: Gathering information in the field**

This stage involves the process of collecting information manually and digitally directly onto the drone-generated images. In Barrios Altos the mapping process started by gathering information about the multi-family housing units in each selected urban block, recording different types of property ownership, land use, building heights, construction materials and condition of the built structures. The aim was to identify the range of conditions that produce risk at the urban block level. This method was also applied in José Carlos Mariátegui to understand the territory as a whole, allowing the examination of different actions taken at a wider scale that affect individual settlements, as well as the whole ravine in which they are located.

The information gathering process in the field promoted the interaction of community mappers with a large number of women and men dwelling in both areas. The mapping process was designed to create a better understanding of everyday risk and episodic disasters, while promoting collective action to respond to unwanted changes in the two study areas (Fig. 20).

In the case of San Juan de Lurigancho, the mapping process was articulated to a series of capacity-building workshops run by CENCA, a progressive NGO and partner in cLIMA sin Riesgo with a long-established presence in the area. The entire process helped raising awareness and strengthening local capacities, and encouraged the participation of community leaders and local inhabitants. This process was particularly targeted towards young people, who were trained as community mappers, enabling them to gain a better understanding of the reality affecting their own neighbourhoods.

**Step 5: Organisation and data analysis**

This stage includes the transfer of all spatialised data collected in the field by the mapping team, into the geographic information system QGIS. It also involves the cleaning and sorting of all georeferenced entries, allowing a reading of the variables on the digital cartographic base. The analysis of spatial information enables a greater understanding of risk accumulation over time (Fig. 21).

**Step 6: Visualisation**

The project shares non-confidential information gathered throughout the research process, in the form of publicly accessible ‘Online Story Maps’.
These maps offer a nuanced reading of the actual conditions shaping urban risk traps and allow those involved in the research, as well as other audiences, to understand how risk accumulation cycles operate. The Online Story Maps can be easily navigated to apprehend: 1. the different causes of everyday risk and episodic disasters; 2. where and why potential impacts manifest; 3. who is affected, why and where; 4. the relationship between different types of risk, and 5. the actions and investments made to mitigate or reduce risk. These maps are hosted on the Geographic Information System (ESRI) digital platform, which allows the visualisation of qualitative and quantitative information. The platform contains a narrative, photos and testimonies from local dwellers in the form of videos organised under different themes in each area (Fig. 23).

4. CONCLUSIONS

cLIMA sin Riesgo promotes participatory, interdisciplinary and interinstitutional mapping, fostering a holistic interrogation of the various risk factors that operate at different scales and timeframes that converge in the production and reproduction of urban risk traps in Lima. This approach makes hidden risks visible, promoting dialogue between different actors to coordinate interventions to mitigate and reduce risk more effectively, and to prevent further cycles of risk accumulation.

Moreover, this process enables those local organisations and public institutions that produce risk maps to exchange experiences and to engage in the application of new methodologies (Fig. 24). The participation of the inhabitants in these exchanges is fundamental to foster potential synergies and co-produce knowledge and action, essential ingredients towards the planning of just and resilient cities (Fig. 25).

Endnotes

(1) Drones are remote controlled airborne devices with cameras capturing up-to-date images. Although there is controversy about their application, if used sensitively, they can help advance the visualisation of typically disregarded realities.

(2) Epicollect + is an open source smartphone application that enables the design of surveys and the georeferenced data gathering and its transferal onto GIS.

(3) QGIS or Quantum GIS is an open source geographic information system (GIS) application that enables data viewing, editing, and analysis.

References


Figure 24: 3D image of the point cloud generated by the drone flights in Barrios Altos (above). José Carlos Mariátegui residents accompanying the drones flight during the ReMap project development (left below)

Figure 25: Peru Minister of Culture Diana Álvarez-Calderón opening the exhibition ‘ReMap Lima - cLIMA sin Riesgo’ (left) and launch of the Mapping Risk Platform for the Lima Historic Centre (centre). Residents from JCM and BA participating in the risk mapping exhibition (right above and below)