Chapter 10: Learning From Co-Produced Landslide Risk Mitigation Strategies in Low-Income Settlements in Medellín (Colombia) and São Paulo (Brazil)[1]

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CO-PRODUCTION AS AN APPROACH TO LANDSLIDE RISK MITIGATION

Low-income communities across the Global South provide themselves with housing and services (see, e.g. Casanova in Chapter 3 of this book). There has been increasing recognition of this, with urban policy and management initiatives focused on supporting and supplementing community-based efforts, ranging from financial mechanisms to co-production arrangements though these are still rare. Approaches to co-produced service provision in the urban South have been examined in a growing literature, as reviewed, e.g., in d'Alençon et al.

1 This paper has been produced based on the collaborative work of the above authors, together with the communities of Pinares de Oriente, El Pacífico and Carpinelo 2 in Medellín, and supported by the Mesa de Vivienda y Servicios Públicos Domiciliarios de la Comuna 8, Mesa de Desplazados de la Comuna 8, Corporación Con-Vivamos and Corporación Montanoa; and with the community of Vila Nova Esperança in São Paulo, supported by TETO Brasil, and with the active involvement of staff from the Instituto Geológico and the Instituto de Pesquisas Tecnológicas of the State of São Paulo.

(2018). Service co-production is increasingly seen as a way of securing sustainable access to key services, such as energy, water supply, sanitation and waste management, relying on contributions from residents as well as from public or private agents (e.g. Allen 2012; Batley and Mcloughlin 2010; McGranahan 2013; Mitlin 2008; Moretto and Ranzatto 2016). The concept of co-production was initially developed in the late 1970s, where it focused on the delivery of services, as 'the process through which inputs used to produce a good or service are contributed by individuals who are not "in" the same organisations. Co-production implies that citizens can play an active role in producing public goods and services of consequence to them' (Ostrom 1996, p. 1073).

Although various interpretations of co-production have emerged since this initial conceptualisation and there is currently a good deal of ongoing experimentation with approaches to co-production, it could be argued that these have in common that 'Co-production stems from voluntary cooperation on the part of citizens (rather than compliance with laws or city ordinances) and involves actives behaviours' (Brudney and England 1983, p. 63). Watson (2014) identifies both commonalities and differences between co-production and approaches to participation that have developed in planning, such as collaborative or communicative planning. According to Watson (2014), commonalities include: a concern with how state and society can engage in order to improve the quality of life of populations; taking an incremental, evolutionary and social learning approach to social change and state action; and assuming a context of democracy and the ability of 'active citizens' to engage collectively and individually. The differences identified by Watson (2014) include: co-production tends to work outside established rules and procedures of governance in terms of engagement with the state; co-production focuses more on delivery processes and management than participatory planning; bottom-up co-production does not necessarily share the belief of collaborative and communicative planning in debate per se as being able to address issues of power relationships between the actors involved; some co-production approaches rely more on 'learning by doing' than on talk and debate; and some bottom-up co-production approaches have an intention to upscale local practices through global networks, which is not a characteristic of state-led co-production or collaborative and communicative planning.

A particular manifestation of co-production in relation to service provision is 'institutionalized co-production', which according to Joshi and Moore (2004, p. 40) is 'the provision of public services (broadly defined, to include regulation) through regular, long-term relationships between state agencies and organised groups of citizens, where both make substantial resource contributions'. This is characterised by: (1) long-term arrangements developed on a regular basis; (2)

moving away from standardised contractual and/or semi-contractual agreements towards continual renegotiation; and (3) the sharing of control of resources, authority and power between citizen groups and the state. This goes beyond the technical organisation of service delivery, involving the political dimension of resource management i.e., the distribution of power around service delivery (McGranahan 2013).

However, the co-production of risk mitigation in low-income communities is much less common, well-known and understood. Key hazards that low-income communities in the Global South often face include landslides, flooding and fires, as well as the range of socio-economic, institutional and sometimes political threats that heighten their vulnerability. Such events are becoming increasingly frequent and impactful through a combination of ongoing urbanisation and the changing weather patterns that accompany climate change. Working in partnership, researchers at the Universidad Nacional de Colombia Sede Medellín, Heriot-Watt University and the University of Edinburgh, together with community leaders, identified the need to explore the scope for co-production as an approach to help vulnerable communities to address the risk of landslides that affects many settlements in the north-eastern sector of Medellín. This resulted in the first participatory action research project (November 2016-October 2017) called, 'Resilience or resistance? Negotiated mitigation of landslide risks in informal settlements in Medellín'[2]. Participatory Action Research (PAR) can be viewed as a way of 'bringing participation into action research' (Elvin and Levin, cited in Khanlou and Peter 2005, p. 2234). In this project, PAR was the method used to explore the feasibility of the process of co-production discussed earlier, since the outcomes of a PAR methodology should be focused on action and developing new knowledge with emancipatory results for the community (Khanlou and Peter 2005).

In this case, a good deal of what we envisaged as being co-produced was knowledge: of the landslide (and other) risks the community was exposed to, and of the possible ways of addressing these in a way that involved different stakeholders. The project was undertaken by a multidisciplinary team that covered sociology, planning and slum upgrading, geotechnics and environmental engineering, and architecture and construction. The aim of this project was to explore the scope for, and acceptability of, landslide-risk-reducing strategies for informal settlements from the community and state perspectives. The project also sought to understand the barriers to landslide-risk-reducing strategies and to identify

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politically and practically viable approaches to landslide-risk-reducing strategies within a wider and more complex context of social and physical risk (see Smith *et al*. 2017). The concept of 'resilience' in the project title was interpreted following Vale's (2014) identification of 'pro-active preventive resilience', as opposed to 'reactive/restorative resilience', and as a politically engaged form of resilience with a focus on the issues of 'whose resilience' and 'whose city', as advocated by Vale (2014). In the second part of the title, 'resistance' refers both to the approach of community organisations in north-eastern Medellín in dealing with local government in relation to urban planning and landslide risk, in terms of opposing risk-related evictions and defending the right to remain on the land, as well as to 'resistance' as a form of 'resilience' – see Alvarez et al. (2019).

The exploration of community-based disaster-risk management (CBDRM) harks back to Maskrey (1989) and subsequent literature, with most of this focussing on what communities can achieve through spontaneous community disaster-risk management organisation (CDRMO) or in collaboration with universities and/or NGOs (see, e.g., Tanwattana 2018). A few initiatives have been documented and promoted in the literature involving communities working together with government organisations in monitoring landslide risk and implementing landslide-risk mitigation measures, such as MOSSAIC in the Caribbean (Anderson and Holcombe 2013), and Alerta Rio in Brazil. The latter collects relevant data in every neighbourhood of the city, with community involvement, and publishes its results online, with residents developing small emergency plans and mitigation strategies using updated data (Rahman 2012). These initiatives, however, have not tended to be conceptualised or analysed in terms of co-production.

In the area of Medellín, there has been increasing interest in finding ways of involving the community in risk monitoring, such as the project undertaken by the Universidad de Antioquia and the Corantioquia Foundation from 2011-13 to design and put in place an environmental monitoring social network for early warnings of flooding, flash floods and landslides in strategic locations across the 80 municipalities where Corantioquia operates.[3] Key actors were communities and municipalities, using social cartography as a basis for the design of the monitoring network and hand-made easy-to-use instruments to measure rainfall, etc.,

3 Corantioquia is a state-financed organisation that operates within the Colombian Department of Antioquia with the institutional objective of managing the implementation of policies, plans, programmes and projects related to the environment and renewable natural resources. Additionally, Corantioquia oversees that all statutory activities are undertaken according to the guidelines issued by the Ministry of the Environment.

supplemented by electronic instruments for verification. The project trained community members and installed pluviometers (devices used to measure rainwater) and water-level recorders, and was followed up by a further project in 2015 that took place in three municipalities. However, these experiences do not appear to have been evaluated.

In terms of mitigation, Empresas Públicas de Medellín (EPM – the municipal utilities company) has established a programme of 'community brigades' to detect water leaks in the water supply system, which are rife particularly in informal settlements. These 'brigades' are formed temporarily to undertake 3 to 4 days of work every year, managed by EPM, and identify leaks and replace informal water supply systems with non-conventional temporary systems installed jointly by community members and volunteers from EPM (EPM 2015). These 'non-conventional temporary systems' are those that are neither structural nor permanent and can provide physical, social or environmental aid, such as undertaking basic upgrades to internal plumbing fixtures within individual houses; helping to manage an overgrown tree within the immediate vicinity of a neighbourhood; and establishing community links within different neighbourhoods (EPM 2015). This is not primarily a landslide-risk reduction initiative, nor a permanent form of co-production, but it reflects the increasing (though still scarce) attempts to address the complex issues of risk mitigation and service provision in vulnerable urban areas a context within which the 'Resilience or resistance?' project experimented further with encouraging results.

PILOTING THE CO-PRODUCTION OF LANDSLIDE RISK MONITORING AND MITIGATION IN MEDELLÍN, COLOMBIA: THE EXPERIENCE OF PINARES DE ORIENTE

The first project piloted the co-production approach during 2017 in a neighbourhood in Comuna 8, Medellín, where the international Colombia/UK research team worked with volunteer community researchers to: understand the perceptions of risk (among community, public sector and third sector); pilot community-based monitoring of landslide risk using mobile phone technology; test low-cost community-built emergency landslide-risk mitigation works; and identify mechanisms for joint decision-making between community and public sector agencies to mitigate risk.

The activities developed to reach these objectives were centred in a neighbourhood located in the upper part of the central-eastern area of Medellín, in

Comuna 8, called Pinares de Oriente (see Figure 1). It is located between 1,738 and 1,824 metres above sea level, covers 1.52 hectares, and is inhabited by 180 families – approximately 800 inhabitants – 80% of whom are victims of the internal social and armed conflict that Colombia has gone through. Colombia has been 'hostage to an intermittent internal war' causing a rural exodus to cities and placing particular pressure on the country's largest cities, such as Medellín (Garcia Ferrari *et al*. 2018). This conflict has been endured as 'three key waves'. There is little reliable data quantifying the number of deaths and internally displaced people in the first wave, La Guerra de Mil Dias, (1899–1903); the second wave (1946–1957) led to an estimated death count of 200,000 to 300,00 and the forced migration of 2 million people, which was equivalent to a quarter of the national population. In the third wave (1984–1999), the continued political violence led to 1.7 million people being forcefully displaced from their homes (Garcia Ferrari 2018, p. 4). Low-income settlements that are informally built and outside of the municipal land-use plan, are to a large extent inhabited by the internally displaced people (IDP) that had arrived in Medellín during the last wave. According to the municipal land-use plan, part of the Pinares neighbourhood is on urban expansion land that has been identified for integrated upgrading and part is outside the urban perimeter; i.e., on rural land. 'La Loquita 1' ravine crosses the settlement, but it only carries water during periods of heavy rain. The local authority has identified in the neighbourhood an area of no risk in the lower part, an area of mitigatable risk, and a non-recoverable area of high risk, which is also the area outside of the urban perimeter, where approximately 70 families are located.

Figure 1: Location of Pinares de Oriente, El Pacífico and Carpinelo 2 in the city of Medellín, Colombia.

Source: Adapted by the authors from a map by Alcadía de Medellín.

Perceptions of risk

Exploration of the perceptions of risk included two focus group meetings with residents and community leaders; sixteen semi-structured interviews with community leaders and residents of Pinares; and six semi-structured interviews with key players from the public sector, in meetings with the people directly responsible for institutional relations with the community on the issues directly related to the process. In addition, workshops and working processes involved third sector organisations. Perceptions of risk among informal settlement residents were explored at different times, from when they arrived in the settlement to during the project implementation. Most interviewed residents have known some risk during their lives, including floods, landslides and fires. The perception of whether they currently live in a risk area is more varied, from ignorance or lack of concern for the conditions of the site due to other concerns that are more urgent and immediate such as subsistence, to knowledge of the risk and willingness to face the consequences. This is influenced by how they see the role of the municipality in relation to risk, which they link to the possibility of eviction. Public sector interviews revealed that state organisations agree on the importance of intervening on the edge of the city and on the need to control new land occupation and to have a positive view of emergency mitigation interventions while integrated neighbourhood upgrading also takes place where conditions permit.

Monitoring of landslide risk

The research team collaborated with a group of residents who were interested in the process and who participated as volunteer community researchers as they were motivated by the knowledge that their participation would bring improvement to their neighbourhood and subsequently to their individual home. The idea was to establish several WhatsApp groups, each of these groups being responsible for taking photographs at several predetermined monitoring points. The photographs were received in Edinburgh and analysed by looking at the following points: chronological comparisons of the images; comparisons and correlations of the images with the average monthly rainfall level; evaluations of mass movements; identification of the most critical points from the point of view of the hazard. These WhatsApp groups became general platforms for monitoring, and volunteer community researchers uploaded various media: photographs, audio clips and videos (Figure 2).

The monitoring work started with the technical team taking preliminary reconnaissance walks with community residents (community researchers) so as to identify hazards, risk conditions and potential monitoring points. Interviews with residents had identified concerns about moisture, water springs and floods. Using the information provided by the community and the technical team's appraisal, fourteen initial points where the community monitoring work would take place were defined in a joint participatory mapping workshop. Once the points were known, the technical monitoring group in Edinburgh prepared a detailed guide to facilitate monitoring by the community, which indicated the point to be monitored, the frequency of observations, and the safety conditions that needed to be taken into account during these activities.

Figure 2: Screenshots of one WhatsApp Group ('Grupo 4'), showing the images taken by volunteer community researchers of various monitoring points within Pinares de Orente.

Source: Images uploaded by volunteers from the Pinares de Oriente community and screenshots by Helena Rivera, 2017.

The manual or guide was used as the basis for a workshop/training session with community volunteers who were interested in participating in the monitoring. Topics covered included clarifying the meaning of the term 'monitoring' and its importance in a community risk management process, as well as the great importance of taking photos periodically and systematically. The images thus pro-

duced could then be technically analysed by the Edinburgh-based group. The initial selection of monitoring points was extended by participant residents during a subsequent field walk, in which each of the volunteers was given instructions on the specific way in which the photographs should be taken, indicating the importance of the physical feature to be observed.

The monitoring was carried out between the months of May and October 2017, covering a dry period and a rainy one. At the end of this monitoring, the experience was evaluated in two community workshops, and the community researchers, supported by the academic team, shared their experience in the project and its results with the local authority organisations and NGOs.

Through their participation in the monitoring process, community researchers demonstrated that residents in low-income neighbourhoods, with appropriate technical support, are able to be involved in a landslide hazard monitoring system and to collaborate with academic researchers in data collection for analysis. Community researchers took part in the experience in order to improve the community and because they understood the importance of the process. Lessons were learned during this pilot experience about the limitations faced by this type of community participation and on the possible ways in which these community research processes could be optimised. These included the following:

- difficulties regarding the regularity of photograph taking and sending, linked to other priorities and events in the volunteers' daily lives;
- decrease in the number of participants, with only two out of the six initial monitoring groups sending photos throughout the process, due to technical difficulties with the mobile phone, changes of the residence of some participants, and family circumstances; and
- the detail of the photograph: some sent small videos which, although important in communicating the seriousness of flooding in the settlement during heavy rain, did not contribute to the specialists' technical analysis of the images.
- feeling fully engaged: relying exclusively on the technical analysis of the photographs being done by experts in geolog and geotechnics led to the community researchers feeling less engaged in the pilot experience because they never saw or understood how their photographs were being analysed and used.
- the factors that were identified, together with the community researchers, as possibly leading to more continuous participation, were: local administration of the WhatsApp networks, instead of abroad; closer accompaniment of community researchers through the more frequent presence of a member of the ac-

ademic research team, or possibly students of the university that accompany the process; concentration of effort in a smaller number of monitoring points within the community; and activities in which the methods and results of the analysis of the images collected by the community researchers are shared, so as to reinforce these volunteers' understanding of the process. These informed the strategy adopted in the second project, which is described in the next main section of this paper.

Mitigation of landslide risk

This action research component was based on two main elements: technical analysis of the conditions of the land and buildings, identifying factors that could contribute to landslide hazards, and linking this analysis to the identification of monitoring points; and the establishment of action strategies that are the result of community collaboration and intervention. Therefore, the priorities identified during the project were the result of multidisciplinary workshops, taking into account the knowledge of the expert members of the project's technical team (geologists, engineers, architects, sociologists, etc.), and the community. During these workshops, the community shared their concerns, particularly during the rainy periods, their specific knowledge of the area, identifying key points, and their willingness to take part in the participatory monitoring and risk mitigation processes.

For the technical analysis, an initial roof survey was carried out with the support of university students and two local NGOs: Con-Vivamos and Corporación Montanoa. This was supplemented by perceptual surveys that enabled the establishment of a hierarchy of spaces and networks that, in turn, enabled the prioritising of the points of intervention as well as the more detailed definitions of the character of the works to be executed in each place. This analysis required a considerable investment of time by the technical staff of the research team, given the precariousness of the graphic and cartographic information available.

Analysis of open spaces, buildings and drainage identified four levels of water management linked respectively to four levels in the drainage network, which provided a basis for the prioritisation of low-cost community-built emergency mitigation works. These levels are: (1) at the municipal level, a drainage network situated under the main access roads, which are under the responsibility of the Municipality; (2) at the community/street level, drainage along lanes and stairways, which are the responsibility of the neighbourhood association; (3) at the lane and alley level, drainage in semi-private areas between houses, which are the responsibility of groups of residents living around these houses; and (4) at

the residential level, individual houses, which are the responsibility of their owners. The project gave priority to the tertiary network, with some interventions in the secondary network when deteriorating or deficient areas were identified. A number of interventions were also carried out in individual dwellings, generally in the case of houses that affect others, always seeking to benefit the neighbourhood.

Figure 3: Mitigation works in a semi-private area between houses (tertiary network), in Pinares de Oriente.

Source: Wilmar Castro, 2017.

The works were arranged to be carried out by groups of neighbours through ‘receptions' (convites) or community events during the weekends, supplemented with partially paid work during the week (Figure 3). The construction was led by the consultant architect for the project, and guided and coordinated by a local builder. The community self-build works were carried out during the months of September and October 2017. The initial intention had been that some of the sites where works were carried out were to be included in the monitoring process, but this was not possible as these works were carried out in the final stage of the project. At the end of this period, the mitigation experience was evaluated in a community workshop, and the residents who took part in the convites shared the results from their evaluation with local government organisations and NGOs in subsequent workshops, supported by the academic team. The project demonstrated the potential of mitigating risk, throughout an informal settlement, with a very low budget, community self-build and technical advice.

Seeking community-state agreements over landslide risk mitigation

Ultimately, the pilot project sought, through a collaborative process, to identify ways and mechanisms for developing a sustainable process for the co-creation of a risk mitigation strategy and its implementation through agreements between the communities in the informal settlements and the relevant state agencies at different scales, based on the lessons learned from the activities carried out in relation to perception, monitoring and mitigation. In Spanish, this agreement-seeking process is referred to as concertación.

Agreement (concertación) was achieved at two levels: At the district (comuna) level, within the wider community, addressing the deep differences between the Local Administration Board (Junta Administradora Local) and the Working Groups on Housing and Internally Displaced People (Mesas de Vivienda y de Desplazados): a meeting between these organisations and a joint call for an open council meeting (Cabildo Abierto – a legally-binding type of meeting). This is important for two reasons: (1) because the local administration board, which is the lowest level of local government in Colombia, with administrative responsibility at the district (comuna) level in urban areas, and is elected by residents, has the capacity to convene meetings with the municipality at the city level: and (2) the Working Groups on Housing and Internally Displaced People can mobilise the community due to their constant work in the neighbourhoods these are community-based organisations that coordinate community action across districts and across the city, and are increasingly vocal in relation to the

need to address risk mitigation in addition to other issues that have traditionally been on their agendas, such as recognition of informal settlements, land regularisation and titling and neighbourhood upgrading.

At the level of the community of Pinares, after the Cabildo, a working group was established with participation of the community of Pinares and four departments of the municipality (Planning (DAP), Disaster-Risk Management (DAGRD), Housing (ISVIMED) and the Urban Development Company (EDU)), which are to look at the possible ways forward for the settlement's at-risk area, once the risk survey plans have been approved. In addition, it was agreed that the larger interventions required to mitigate risks (channelling of La Loquita, box-culvert and screens to protect from rock falls) would be analysed to see if these could be addressed using municipal resources.

The community-local government working group around Pinares was established during a series of steps designed to provide opportunities to establish co-working practices between the local government and the community, which had the following sequence:

- A community evaluation workshop, with the participation of the community-based researchers (residents of Pinares de Oriente) and leaders, which included a role play exercise to help the community prepare for the multi-stakeholder workshop at neighbourhood level.
- A multi-stakeholder workshop at neighbourhood level, with the participation of representatives of the community and those responsible from the main relevant public organisations, which took place in the settlement and included an opportunity for the community volunteers to show the local government officials the results from the monitoring and mitigation pilots on-site.
- A workshop with NGOs and other organisations that work with the community, and whose participation the research team considered important towards the roll-out of the experience in the follow-on project.

Evaluation of the pilot monitoring and mitigation projects, and multi-stakeholder workshop discussions showed that the following factors can facilitate the process of reaching agreement among the different stakeholders involved in landslide-risk mitigation (in this case mainly community and local government): (1) engagement with the different stakeholders from an early stage, though not necessarily together in the beginning; (2) knowledge of the capacities and responsibilities of each stakeholder; (3) consideration of timescales (in this case, a focus on the short term – 'the meantime' – was key in achieving agreement between

community and local government); and (4) consideration of the resources that can be brought to bear, including community resources.

THE ROLL-OUT OF CO-PRODUCTION OF LANDSLIDE RISK MONITORING AND MITIGATION IN MEDELLÍN AND SÃO PAULO

The above pilot experience was rolled out, during 2018, in two further communities in Medellín, and another one in São Paulo, in order to explore and identify the issues that may arise in transferring the pilot experience to different socio-economic and political contexts within the same city (but in neighbourhoods and districts with different histories) and in a city in a different Latin American country. This was achieved through a project called 'Co-production of landslide risk management strategies through development of community-based infrastructure in Latin American cities', which ended in May 2019.[4]

The experience of replicating co-production of landslide risk monitoring and mitigation in El Pacífico and Carpinelo 2 in Medellín

In Medellín, the follow-on project was implemented in one settlement within the same district (Comuna) as the pilot project and in another in a different district (Figure 1). El Pacífico is located at the high end of Comuna 8 (not far from Pinares), on land that is partly classed as at high risk because of its being within the officially required setback from 'La Rafita' ravine, partly outside the official urban perimeter, and partly within a forest reserve. According to a community census undertaken in 2016, there are 184 households, with the majority age group being that between 18-29 years old and with 79% of the population having been displaced by the armed conflict. Originating around 1995, this densely built-up and consolidated settlement has a strong history of community organisation, with a Junta de Acción Comunal and a track record in engaging with the municipality (Figure 4).

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Figure 4: El Pacífico (left) and Carpinelo 2 (right), in Medellín.

Source: Images taken by the Medellín research team, using a drone, 2018.

Carpinelo 2 is a more recent and much less consolidated settlement. It is located in Comuna 1 at the north-eastern tip of Medellín, high up above the city on a steep slope overlooking the next municipality to the north. On the upper edge of a wider neighbourhood called Carpinelo, which started to form in the 1970s and was recognised in 1993, Carpinelo 2 started to form in the late 1990s and early 2000s and became a neighbourhood in its own right in 2012. Carpinelo as a whole has approximately 2,600 households, and Carpinelo 2 is a less densely inhabited part of this, with a considerable amount of open space and lower access to public services, with untreated water, e.g., being tapped into it from a pipe higher up the hill and distributed to houses via pipes installed and charged for by people linked to the armed groups that control the territory. There have been recent instances of evictions and house demolitions in the neighbourhood due to imminent landslides, but residents continue to engage in cutting into the hillside and moving earth to build homes (Figure 4).

Perceptions of risk

In both communities, the research team went through a lengthy negotiation process with locally-based NGOs that have been supporting the two communities (respectively, Convivamos and Corporación Montanoa), establishing rules of engagement with the community in setting up the processes and looking towards the future sharing of the results and the appropriate acknowledgement of those involved in the co-production of knowledge. The process of interviewing community residents and leaders faced some interruptions due to national events, such as the presidential elections, but was eventually completed with 13 inter-

views in El Pacífico and 15 in Carpinelo 2. Perceptions of risk in each settlement vary somewhat, with residents in El Pacífico being more concerned about rock falls, as well as reporting some flooding and problems with poor building quality, while in Carpinelo 2 there was more explicit concern with landslides and with water including the link between water and landslide risk.

Monitoring of risk

Building on the lessons learned from the pilot project in Pinares, the participatory mapping and training of the volunteers who were to undertake community-based monitoring took longer, with more sessions taking place with the community members, while at the same time limiting the number of monitoring points (4 in El Pacífico and 6 in Carpinelo). In addition, the technical problems and perception of distance between data collection and data analysis that were found in the pilot project were addressed by establishing a system of small weekly top-ups of volunteers' mobile phone allowances in exchange for weekly photographs, with the latter being sent to a WhatsApp group that was managed by a community leader in Medellín (who is part of the research team), rather than to the UK-based researchers.

Figure 5: Community volunteers in Medellín analysing the landslide-risk monitoring data they had collected.

Source: Carlos Montoya, 2018.

This resulted in more consistent participation of community volunteers and therefore in more systematic data collection. In addition, instead of relying exclusively on technical analysis of the photographs by experts in geological and geotechnics a process that had not led to the community researchers feeling fully engaged in the pilot experience in the follow-on project, community workshops were held at regular intervals so as to allow joint analysis of the sets of photographic data by community volunteers together with the research team (Figure 5). This not only helped towards developing the community's knowledge of their own territory but also, and even more importantly, towards their capacity to engage other stakeholders with systematically collected data of their own, thus strengthening the community's involvement in the co-production of landslide risk management.

Risk mitigation

In terms of mitigation, a major difference with the pilot project was the lack of funding available to implement small self-built works. In the follow-on projects, the emphasis was on the co-production of a strategy for each of the settlements, which provided the respective community organisations with a document that recorded possible interventions and mapped the stakeholders that would need to be involved in their implementation, for the Junta de Acción Comunal to take forward. It was considered that the hierarchy of spaces and networks developed in the pilot project remained valid for the two further communities in Medellín, while the importance of the principle of linking walking routes with water drainage became more evident. A particular challenge was faced in El Pacífico, where the high ratio of land occupation by construction and the little amount of space for circulation (of both people and water) raised the possibility of proposing a certain level of building removal, which in itself would risk creating conflict within the settlement.

Agreement-seeking (concertación)

In relation to agreement-seeking, the follow-on project benefitted from both what was shown to be possible by the pilot project and a general move towards an improving community/state relationship in the city (whereas the community/academia relationship has already been positive for a much longer time). The state has tended to feel under pressure from community mobilisations, but more sophisticated forms of engagement between the two have been lowering the tensions. An example of this is the in municiaplity having awarded a prize for citizen participation to the 'Hillside Neighbourhoods School' (Escuela de Barrios de Ladera), an initiative that brings together academia and community or-

ganisations in NE Medellín, with the support of Convivamos, and which has incorporated the experience of the projects that are presented in this paper. In addition, almost as a repeat of the research team's experience of presenting the pilot work at a public Cabildo in 2017 for Comuna 8, in 2018 the Medellín research team leader was invited to facilitate a further Cabildo that addresses neighbourhood improvement and risk management across the whole of north-eastern Medellín. Comuna 8 civil society has become a spearhead in the demand for appropriate risk management, resulting in the municipality prioritising the commissioning of micro-zoned risk assessments for this city district, ahead of all the others. This is seen as a first step toward a risk management plan for the whole of north-eastern Medellín.

Transferring the experience of landslide risk management co-production to São Paulo

The transfer of the pilot experience and lessons learned in the case of Medellín to the context of São Paulo was facilitated by two visits of the Brazilian research team to Medellín, where they took part in the final forum that was held there to disseminate the results of the pilot experience and where they also visited and took part in workshops in the participating communities; participation in theme-focused webinars involving the three research teams in Brazil, Colombia and the UK; and weekly project management skype meetings. Replicating and contextualising the experience in São Paulo was not an easy task, with initial reflections mainly highlighting the differences in socio-political and security contexts and in the way that contact between the research teams and potentially participating communities was established.

In early 2018, the São Paulo research team had started working with an informal settlement in the south-east of the city, Morada do Sol, which consists of areas at risk of landslides. Contact was initiated with the community through a relationship that the University of São Paulo has with state-level civil defence in the district of Butanta, where the settlement is located. Representatives from Civil Defence recommended working in this settlement because of its level of community organisation, and the research team visited the area and held a community workshop. However, visits soon had to be suspended because of clashes between police and druglords, which turned the settlement into a no-go area for outsiders. The Brazil-based research team then turned to a contact within the NGO CEDECA (Centro de Defesa da Criança e do Adolescente – Centre for the Defence of the Child and the Adolescent), an organisation that is working in a low-income settlement in Sapopemba, on the eastern edge of the city. The set-

tlement is divided into two parts, a cluster of dwellings at the top of a hill that is partly constituted by rubbish the inhabitants tip down the hill, and another cluster in the valley. Landslide risk here involves not only soil movements but also rubbish sliding as well as catching fire. Initial meetings with the CDEC and a community leader were promising, but it eventually became clear that powerful individuals who were building relatively high buildings for rent in the settlement did not welcome external interference, and the research team had to discontinue the engagement.

Figure 6: Location of communities where the transfer of experience was attempted in São Paulo (left) and an aerial view of Vila Nova Esperança (right).

Source: Prepared by the authors using Google Maps.

Eventually, through the NGO Teto, the Brazil-based research team established contact with the main community leader of Vila Nova Esperança, a 450-household settlement in the south-west of the city, which has landslide-risk issues, including areas classified at high and very high risk. The 60-year old neighbourhood, which is surrounded by a protected forest, is involved in a process of land regularisation which in principle is not applicable to high and very high-risk areas unless mitigation works are carried out hence the community leader's interest in involving the community in the project. Having finally agreed to a collaboration with the community by August 2018, the Brazilian team was able to adapt the Medellín experience to Vila Nova Esperança. It undertook

interviews with the community, started a community-based monitoring system based on four agreed monitoring points, and assessed the requirements for community-based mitigation.

The experience of transferring the approach internationally from Colombia to a Brazilian context allowed the team to draw out preliminary lessons regarding the limitations faced by this type of community involvement and on the possible ways in which these community research processes can be optimised. These lessons included the following:

- different participatory surround: understanding the socio-political and security contexts is fundamental and will have an impact on the way a project is co-produced. The socio-political and security contexts will vary widely even amongst continental neighbours, so addressing this at an early stage is fundamental;
- including a community member within the academic research team: the way that contact between the research teams and potentially participating communities is established has an impact on the level of trust that the academic team has within the community. This 'trust' is fundamental for co-production;
- linked to the above point, different socio-economic processes within the neighbourhoods can enable or hinder community willingness to engage with external actors, and the involvement of a community member in the research team from the outset can help understand these processes;
- landslide diversity: the type of potential landslide and its secondary effects will, like all so-called 'natural' hazards, vary widely between geological regions and settlement characteristics. In this case, the project had to momentarily contend with rubbish sliding and the secondary effect of catching fire, both of which require an entirely different set of mitigation strategies.

CONCLUSIONS

The research shows that different levels and ways of understanding landslide risk can be found within different communities, linked to the history of each particular settlement, which in turn affects how such communities engage with external agencies (e.g., local government) in relation to this endeavour. In addition, risk governance and management involve different approaches in different cities and are linked to the general approach to informal settlements in each city and to state capacity. The tendency has been to focus on post-disaster attention and

recovery rather than prevention and mitigation, with the latter manifesting mostly in interventions which run counter to establishing relationships of co-production (e.g., preventative evictions).

The projects described in this chapter have explored alternative ways of engaging vulnerable communities and the local government in each city in co-producing landslide risk management strategies. Lessons learned along the way suggest the need to engage the community as much as possible not only in data collection and in implementation of emergency mitigation works but also in the analysis of the data they collect, in developing their own knowledge and understanding of their territories, and in the development of settlement-level strategies they can use in lobbying local government for resources and in prioritising actions together with local government agencies. The experience of trying to roll out the pilot project to other communities in Medellín and to transfer it to a different context in the city of São Paulo highlights the influence the socio-political and security context can have on such replication as well as the importance of considering the routes to engaging vulnerable communities in this kind of work.

As climate change and the continued informal growth of cities on hazardous terrains increase their inhabitants' exposure to potential disasters, developing ways of co-producing landslide-risk mitigation that optimises the use of community and state capacities to provide safe homes is becoming increasingly urgent. The two projects that are described and analysed in this chapter have shown both the potential and the challenges not only of developing such co-produced landslide-risk-management approaches but also of the co-production of knowledge to underpin the development of such approaches through collaboration between academia and the community primarily, as well as with NGOs and the relevant legal government organisations. On reflection, a key element underpinning success in the co-production of research appears to be the existence of shared objectives between academia and community, as it can be achieved especially in the Colombian cases, and the open acknowledgement of these as well as of the differences in the agendas of the key actors. This also applies to the involvement of other actors, with an example being the protracted and detailed negotiations that took place between the academic researchers and the NGOs supporting the two communities that the experience was rolled out to in the second project in Colombia. This ranged from dealing with issues around what the project deliverables would be, to the recognition of joint authorship. Thus, our experience in these projects tells us that co-produced research requires transparency in the agendas, confluence in the objectives, and a willingness to negotiate and resolve differences that may emerge during the research process, which is inevitable given the open-endedness of participatory action research.

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