A Conceptual Framework for Flood Impact Mitigation Through Transboundary River Management

G. Clegg1, R. Haigh1, D. Amaratunga1, H. U. Karunarathna2, H. P. Rahayu3 and D. Septiadi4

1 Global Disaster Resilience Centre, University of Huddersfield, Huddersfield, United Kingdom
g.clegg@hud.ac.uk

2 College of Engineering, Swansea University, Swansea, United Kingdom
h.u.karunarathna@swansea.ac.uk

3 Department of Regional and Urban Planning, Institute of Technology Bandung, Bandung, Indonesia
harkunti@gmail.com

4 School of Meteorology, Climatology and Geophysics, Tangerang, Indonesia
deni.septiadi@stmkg.ac.id

ABSTRACT

It is acknowledged that for successful mitigation of flood risk there is a need for a holistic, basin-wide approach and coordination among all relevant stakeholders. This is particularly important in transboundary river basins where a river may pass through multiple jurisdictions and where the actions of multiple stakeholders must be coordinated from source to mouth. Having effective river basin governance arrangements in place can help to manage flooding successfully. However, it is not always clear what form these arrangements should take to be effective.

In order to understand how transboundary river management arrangements can be improved to mitigate flood hazard impacts, it is first important to identify the nature of the existing management arrangements and how they relate and interact with the flood hazard. To do this, a conceptual framework was developed. The framework firstly outlines the flood hazard itself in terms of drivers and impacts. It then goes on to establish the associated transboundary governance and river management arrangements and seeks to identify any interdependencies. The paper focuses in particular on the Ciliwung River basin, Java, Indonesia.

Key concepts were drawn from a review of the literature. The literature searches were conducted using online databases and search engines. The review included published journal and conference papers as well as reports published by organisations which were identified through online searches.

The framework highlights multiple interrelated drivers of flood risk, both human and physical. There are also a range of governance issues related to capacities, coordination of institutions and fragmentation of plans and policies identified within the river basin, which need to be overcome.

Due to the complexities of flood risk and river management, this conceptual framework provides much needed clarity to facilitate future research on transboundary management in relation to flood risk in urban and peri-urban river basins. It sets a framework for the development of improved transboundary management arrangements in the Ciliwung River Basin.
1 INTRODUCTION

Floods have the highest frequency and widest geographical distribution of any natural hazard worldwide [1]. Despite efforts to manage flooding and reduce its impacts, trends show that there has been a steady rise in the frequency of floods experienced around the world [2]. Extreme hydrological events have increased by more than 50% this decade and are now occurring at a rate four times higher than in 1980 [3], and with this, the number of people affected and economic impacts are growing [4].

Jakarta, the capital city of Indonesia, has experienced this growing flood trend, with the impacts of floods increasing in severity in recent years. Major floods in 1996, 1999, 2002, 2007, 2013 and 2014 resulted in unprecedented levels of damage [5]. In January 2013 floods displaced 40,000 people and incurred 775 million US Dollars in damages [6], exemplifying the scale of this serious problem.

The causes of increased flooding originate not only from physical drivers but also from social, economic and political ones [7]. These drivers are multiple, interrelated and interacting, meaning that to address flooding successfully a holistic and integrated approach is required, with coordinated action between institutions and across sectors. Nevertheless, effective implementation of coordinated flood management can be a challenging task. This is especially true in urban river basins. Rivers can span long distances from source to mouth and may traverse through multiple administrations, jurisdictions, regions or countries [8]. They form interconnected systems where activities in one location can have impacts elsewhere in the basin [9]. The Ciliwung River, which flows through Jakarta, connects two provinces and four municipalities. In these so called ‘transboundary’ river basins the number of actors required to coordinate is multiplied. This issue is compounded by different political, legal, institutional and technical environments across which to coordinate, and that adds further complexity [10]. Uncoordinated action is insufficient, or may even act to make the problem worse [4]. Therefore, more appropriate river governance and flood management arrangements are urgently required for the Ciliwung River Basin to tackle the growing flood problem.

In order to support the development of improved governance and flood management arrangements in the Ciliwung Basin, a conceptual framework was developed. The framework aims to highlight the key concepts relevant to the management of flooding in the Ciliwung River Basin and seeks to identify any relationships between them. The framework was developed as part of the project ‘Mitigating hydrometeorological hazard impacts through improved transboundary river management in the Ciliwung River Basin’ and is designed to support the project’s future work. This three-year interdisciplinary project aims to understand how transboundary river governance arrangements in the Ciliwung River Basin influence flood hazard impacts and will develop plans for improved transboundary governance arrangements for the management of flooding.

The remainder of this paper is structured as follows: It begins with a background to the flood management issue, a definition of key terms and sets out the methodology for the development of the framework. The conceptual framework is then presented, divided into three subsections on flood risk drivers, flood impacts and transboundary governance and river management. The final section of the paper presents a summary and conclusions.
2 BACKGROUND

2.1 The Flood Hazard

A flood can be defined as “A high water level along a river channel or on a coast that leads to inundation of land that is not normally submerged” [11]. There are several different types of floods, including fluvial (river), pluvial (surface), coastal, urban, flash and outburst [1, 12]. Flooding itself is an outcome of multi-scalar interactions among climate, landscape physiography, river-valley morphology, and hydraulics [13] and as such, is part of the inherent variability of nature. But flooding is also closely linked to human activities, forming complex interactions between natural and social processes. The fundamental issue is that when a severe flood occurs in an area occupied by humans, it can have severe impacts on society, the economy and the environment [14].

2.2 Integrated Flood Risk Management

Traditional approaches to flood management have focused on mitigating the physical hazard only, but increases in the severity of flood impacts has indicated the inadequacies of this approach. As a result there has been a shift towards Integrated Flood Risk Management (IFRM) that promotes a unified method where more diverse strategies are applied and coordinated [15]. Contemporary IFRM acknowledges that activities within a river basin are interconnected and interdependent [16], as such, they should be coordinated across the basin. It also recognises that, in addition to the physical hazard, flood impacts are a result of social, economic and political factors. Thus, a diverse spectrum of actions is required to address them. IFRM promotes a combination of traditional ‘hard’ engineering with ‘softer’ measures, for example sustainable planning and development, in order to address flooding holistically.

2.3 The Transboundary River Management Problem

Rivers can span long distances from source to mouth and may traverse through different administrative areas, jurisdictions, regions or countries [8]. They form interconnected systems where activities in one location may have impacts elsewhere within the basin [9]. These so-called ‘transboundary’ river basins are particularly challenging in terms of coordinating efforts basin-wide. The numbers of actors involved in flood and river management are multiplied in transboundary basins [8], and coordination may be required across different political, legal, institutional and technical settings [10]. Despite the need for coordinated action on flood management across boundaries, it is currently unclear how existing management arrangements influence floods and in what ways they can be improved to mitigate flood impacts more effectively [16, 17].

2.4 Flood Risk in Jakarta

The Ciliwung River originates near Tugu Puncak between Bogor and Cianjur regencies, and traverses north, through the capital city Jakarta to Jakarta Bay. The river passes through two provinces (West Java and the Special Region of Jakarta) and four municipalities (Bogor Regency, Bogor City, Depok City and Jakarta City). Indonesia’s decentralised government system means that each of these municipalities has the authority to make its own plans and address its own priorities. Decentralisation has also resulted in more institutions responsible for flood management distributed across various levels of governance (national, provincial, municipal) [18]. Although decentralisation can contribute to good governance, it can also lead to fragmentation of policies and plans, both horizontally across
different administrations and vertically between levels of governance. This fragmentation presents a particular concern for coordinated management of flood risk.

3 METHODOLOGY

Concepts are ideas that are used to capture or represent the phenomenon being studied [19]. Miles and Huberman [20] describe a conceptual framework as something that “explains either graphically or in narrative form, the main things to be studied – the key factors, variables or constructs – and the presumed interrelationships among them” (p. 20).

The concepts presented in this framework were drawn from a review of the literature focused on the three main areas: flood risk drivers, flood impacts and transboundary governance and river management. For each concept identified, firstly the general background, theory or the global view is presented for understanding. Each concept is then linked to the current situation in the Ciliwung River Basin. In cases where no literature was available for the Ciliwung specifically, information was drawn from sources pertaining to the Jakarta area or Indonesia that could provide potentially relevant insights. Regarding information relating specifically to the Ciliwung Basin/Indonesia, the literature review was limited to the most recent documents available in order to present the current status.

Flood risk drivers were identified from an initial literature search using the following search terms (and terms in combination): e.g. ‘flood risk’; ‘drivers’; ‘causes of [flooding]’. Once an initial list of drivers was identified a second search into each driver itself was carried out in order to gain greater depth. Each term was then searched in conjunction with the following terms: ‘Ciliwung river’; ‘Jakarta’; ‘Indonesia’ to identify any previous research conducted at the study location. The same method was applied to identify flood impacts, this time using relevant search terms e.g. ‘flood impacts’; ‘socio-economic’; ‘environmental’; ‘human’.

A review of literature relating to transboundary governance and river management was then conducted. In identifying concepts relevant to flooding in terms of transboundary governance and river management, Savenije and van der Zaag’s [21] framework for the sharing of transboundary waters was drawn upon. The framework takes the form of a ‘classical temple’ with three pillars: the political pillar, the legal/institutional pillar and the technical/operational pillar. All three pillars are required to achieve the balanced sharing of waters, with integrated water resource management as the foundation. Although this framework is designed for the management of international waters, many of the same principles apply across borders within a state and therefore provided a starting point from which key governance and management concepts could be drawn and built upon. Relevant search terms (and terms in combination) included e.g. ‘river management’, ‘transboundary’, ‘governance’, ‘transboundary crisis management’, ‘flood risk management’. As there was limited literature pertaining to transboundary river management in Indonesia, the search was broadened to issues relating to governance and disaster risk reduction in Indonesia that may have bearing.

The literature searches were conducted using online databases and search engines. The review included published journal and conference papers which were identified through the University of Huddersfield’s library (‘Summon’) and Google Scholar portals, as well as reports published by organisations (e.g. World Meteorological Organisation) which were identified through online searches (Google).
4 THE CONCEPTUAL FRAMEWORK

4.1 Flood Risk Drivers

4.1.1 Precipitation

Precipitation may contribute to pluvial (surface water) flooding, where precipitation exceeds drainage capacity or fluvial (river) flooding, where precipitation increases river discharge to the point where capacity is breached [14].

Precipitation on a large scale is driven by climatological regimes. Jakarta experiences a tropical monsoon climate (type Am, Koppen Climate Classification) [22] which exhibits distinct wet and dry seasons associated with shifts in wind direction [23]. The wet season brings heavy monsoon rains and flooding is common during the peak months of December to February [24].

Several other factors may influence precipitation amounts. High temperatures in the equatorial region generate frequent convective precipitation all year round (not only during the wet season) [25]. Although convective rainfall may be localised and short lived, it can be intense, generating high accumulations over a short time period.

In addition, orographic lift, the effect of air rising over high ground, can create heavy precipitation in upland regions [23], such as over the mountains of central Java. Rainfall has been noted to be particularly heavy in the upper Ciliwung basin [26], with annual rainfall amounts in the upper watershed exceeding 3000mm [27].

4.1.2 Storm Surge

Extreme weather events such as cyclones can generate heavy rainfall leading to fluvial and pluvial flooding as described above, but may also present a driver for coastal flooding via storm surges. A storm surge is a rise in sea water above the expected astronomical tide and forms as a result of strong onshore winds and/or temporary increases in sea level due to low atmospheric pressure driven by the storm [28]. Storm surges have been noted along the Java coastline and may contribute to increased flood risk if in combination with spring tide conditions [29].

4.1.3 Climate Change

‘Climate change’ refers to increasing global temperatures due to increasing concentrations of heat-trapping gases in the atmosphere, but also encompasses a range of associated changes in climate phenomena such as sea level rise and extreme weather events [30]. Such changes are likely to have knock-on effects for pluvial, fluvial and coastal modes of flooding.

The increase in atmospheric temperatures is expected to influence the frequency and intensity of precipitation, including that produced convectively and that generated by the monsoon. In Indonesia there is evidence that precipitation events are becoming more intense, particularly during the wet season [22]. Monsoon rains are expected to intensify due to increases in atmospheric moisture globally, with the likelihood of future increases in precipitation extremes related to the monsoon identified to be very likely for the Southeast Asia region (>90% probability) [31].

Rising sea levels as a result of ice mass loss and thermal expansion of ocean waters are likely to increase coastal flood risk [32]. In the Jakarta Bay area, altimetry measurements have indicated that sea levels rose at a rate of approximately 6mm per year over the period 1993-2012 [33].
4.1.4 Geography and Morphology

The geography of the region and the morphology of the river basin also play a role in determining the likelihood of flooding. Jakarta is located on a low-lying deltaic floodplain placing the city at risk of coastal flooding. Subsidence of the land due to compaction of alluvial soils further contributes to coastal flood risk. It is estimated that around 40% of Northern Jakarta lies below sea level [34], with land subsidence rates between one and fifteen centimetres per year depending on location [35]. The morphology of the river basin and channel can influence the likelihood of overtopping and inundation. For example, basin characteristics determine rapidity of runoff influencing the speed at which water reaches the river channel and the speed in which peak flow is reached. Factors that influence runoff speed include stream network density, slope gradient and permeability of soils [14].

4.1.5 Land Modification

Deforestation and removal of vegetation are known to impact runoff by reducing interception, evapotranspiration, infiltration and water storage and increasing erosion and siltation [36]. Modification of hillslopes for agricultural production can alter flow paths, flow velocities, and water storage, and consequently flow connectivity and concentration times [37]. In the upper reaches of the Ciliwung River Basin, land has been cleared for agriculture (primarily tea plantations) [27]. Studies have identified an intensification of basin response and increases in peak flow and sediment load which have been attributed to land clearance in recent years [18, 26].

4.1.6 Population Growth

Global population has increased exponentially over time, particularly in urban areas of developing countries. Global population is expected to continue to increase in the future, with Indonesia expected to see a significant proportion of this. Fifty percent of the population growth between 2017 and 2050 is expected to be concentrated in nine countries, Indonesia being the ninth by expected contribution [38]. With growing population there is a growing number of people exposed to flood risk. It has been estimated that, worldwide, approximately 21 million people are already exposed to river floods alone. This could more than double to 54 million people by 2030 as a result of socio-economic development and climate change [39].

4.1.7 Rapid Urbanisation

Population growth increases demand for housing, services and infrastructure, driving urbanisation. With urban expansion spreading into flood prone areas, a greater number of people and assets are placed at risk of flooding. Guneralp et al., [40] estimated that by 2030, 40% of total global urban land will be located in high frequency flood zones compared to 30% in 2000. They note that urban expansion is likely to contribute to increased flood risk in the future, even without the additional effects of climate change.

In developing countries, the rapidity of population growth has outstripped the capacity of governments to meet development demands and has led to poorly planned and managed urban development [41]. This has contributed to the spread of urban areas into flood risk zones such as flood plains [42] and has led to development that lacks consideration for appropriate drainage measures, for example [7].
The Jakarta urban area increased an estimated 200x between 1972 and 2012 [26]. However, it has been noted that this rapid urban development occurred faster than the development of plans to guide it [43]. Urbanisation both upstream and downstream, plus very low availability of open permeable green space in the city, have been noted to contribute to reduced infiltration and increased run off [44, 45]. The development of wetland areas and modification of waterways has acted to reduce drainage and retention capacity, increasing flood risk further [5].

4.1.8 Socio-Economic Conditions

Social vulnerability is the product of social inequalities and place inequalities and is determined by access to resources, political representation, social capital, social networks and socio-economic status [46]. Those with higher social vulnerability are often more at risk of flooding than others [47].

Urban development and the increased cost of living in Jakarta have squeezed the urban poor into marginalised spaces, leading to the development of illegal settlements along many of the city’s rivers. The banks of the Ciliwung in particular are heavily populated, placing marginalised groups at greater risk of flooding [48]. Texier [44] identifies that the Jakarta Government often blames riverbank settlers for increased flood impacts as these settlements have increasingly encroached into flood risk zones. This has led to initiatives that seek to relocate riverbank settlers to elsewhere. However, the settlers are sometimes reluctant to relocate because their livelihoods depend on being centrally located or close to the river/coast, for example [48]. Texier [44] notes that it is these socially and economically related processes within the city that have forced the vulnerable into hazard zones. In this sense, socio-economic conditions drive vulnerability and exposure and present a significant driver for flood risk.

4.1.9 Land Subsidence

Subsidence of the land surface in relation to sea level can increase the risk of coastal flooding. In Jakarta, land subsidence has both anthropogenic and physical drivers [49]. Due to the situation of Jakarta on an alluvial flood plain, natural compaction of the soils has contributed to reduced elevation of the land. This is further compounded by human activities. Rapid population growth has resulted in urban development and increased rates of groundwater extraction to meet demand. This ground water consumption has contributed to increased subsidence. In addition, impermeable urban surfaces reduce ground water recharge and the added weight of the built environment add to further exacerbate subsidence [35]. Studies have indicated that soil water extraction is one of the greatest contributing factors to subsidence along with urban development [35].

4.2 Flood Impacts

4.2.1 Human

Of all natural hazards, floods have impacted the most people in the 21st Century. In 2018, floods accounted for 24% of natural hazard related deaths (the second largest cause behind earthquakes) and 50% of the total number of people affected by natural hazards [50]. Such impacts include displacement, loss of life, livelihood and health issues.

In Jakarta, the 2007 flood event was one of the most severe experienced by the city and resulted in over 58 fatalities. The floods were also recorded to have secondary impacts on
human health. For example, outbreaks of Dengue, Leptospirosis and Diarrhoea were recorded after the event, associated with poor water hygiene (OCHA in Texier [44]).

Major flooding in 2013 displaced an estimated 40,000 people [6]. Residents impacted by floods often move to temporary accommodation if they are evacuated or may relocate permanently if their homes are damaged [6]. In particular, the informal settlements that line the riverbanks in Jakarta can be susceptible to flood damage, which can result in displacement of these populations [44].

Floods can also impact heavily on peoples’ livelihoods by effecting their ability to carry out daily activities and through preventing people accessing their place of work [51]. Those who work in the informal sector and those relying on vulnerable industries such as fishing are particularly at risk [44].

4.2.2 Economic

Flooding in urban environments can impact heavily on the economy through damages to buildings, utilities, housing, household assets and transport systems, and can result in losses in industry, trade and employment [7]. The major floods in Jakarta in 2002, 2007, 2013 and 2014 resulted in billions of dollars of economic damage. Estimated total losses incurred from the 2007 and 2013 severe flood events were 565 million US Dollars and 775 million US Dollars respectively [6].

The greatest economic damages in Jakarta are associated with flooding in the central business district (CBD) where inundation has previously forced businesses and government agencies to close, bringing economic activity to a standstill [52]. Businesses in the CBD have been further impacted in the past by disruption of the transport networks and gridlocked traffic [53]. Economic losses due to property damage are also great. The greatest proportion of losses during the 2007 flood event was suffered by the residential sector, accounting for 74% of losses (BAPPENAS in [6]).

Climate change is likely to increase economic damages from flooding globally. It is estimated that, depending on the socio-economic scenario applied, a 1.5-degree Celsius increase in temperature could increase directly incurred flood damages by between 160% and 240% [54]. In Jakarta, Hallegatte et al., [55] calculated that there could be over a 50% increase in average annual losses from coastal flooding in 2050 compared to 2005 under a scenario of optimistic sea level rise and where current flood defence standards are maintained. Under more pessimistic scenarios, where no adaptation takes place (no defence upgrade), mean increase in losses could be over 1000%.

4.2.3 Environmental

Floods can have positive impacts on the natural environment, for example by providing nutrients and recharging ground water. However, floods can also cause degradation, especially in areas where natural systems have already been weakened by human activity [56].

As Jakarta is highly urbanised, floods impact most greatly on the built environment. During the 2007 flood approximately 70% of Jakarta was inundated [43] with the highest flood level being 3.5 metres measured in the area of Kampung Melayu [57]. In a survey of households in west and south Jakarta, Wijayanti et al., [6] found that on average, homes were inundated to a height of 86cm, which lasted on average 98 hours during the January 2013 event, resulting in significant damage to the built environment.
4.3 Transboundary Governance and River Management

4.3.1 Political

**Leadership and Political will**

Political will is often cited as necessary for creating an enabling environment for cooperation and a lack of political will can present a major barrier to successful transboundary management [21, 58]. Political will determines how much cooperation takes place by either supporting or undermining it. Differing political will across borders may also present a barrier to coordination as it is often the actor with the most power gains control [59].

Political will may be impacted by changes in leadership, with different leaders having different priorities. A change in leadership may lead to alterations in policies and the implementation of strategies impacting (either positively or negatively) on flood and river management. In Jakarta, Sagala, Syahbid [60] identify that leadership has been a central factor for the success of flood mitigation plans, with some Jakarta governors having pushed forward flood mitigation efforts, while others have not.

**Capacity**

Capacity building ensures that all parties have the adequate resources to take cooperative action and helps to even out disparities in capacity between actors so that coordination can take place [21]. However, capacity building for coordination has been found to be a work in progress in many transboundary basins around the world [10]. In Indonesia it has been noted that some local governments have developed to a greater extent under decentralisation than others, leading to varying capacities across administrative borders which may contribute to difficulties in cross border collaboration [61].

Furthermore, in order to create an enabling environment and provide sufficient support for flood risk reduction, governments require capacity to do so. This depends on the ability of decision makers to provide vision, direction, material and non-material support [7]. The capacity of political leaders can influence the effectiveness of flood mitigation policies and implementation. For example, leaders with an understanding of vulnerability and risk are better equipped to deliver effective flood management policies and drive forward plans that are implementable [60].

**Sectoral Fragmentation**

There are many different sectors concerned with flood management, such as planning, land use, agriculture and forestry etc. [62]. For effective flood management these sectors should align and coordinate their activities [15, 21], however, more commonly, government sectors take a unilateral approach and work independently from one another. Government sectors tend to have their own remits and address their priorities from their own narrow view point [21]. The diverging interests of government sectors can be associated with issues such as institutional fragmentation, overlapping and unclear responsibilities.

With varying needs between locations (e.g. upstream and downstream) in a transboundary river basin, the priorities of one sector may not be aligned with the priorities of the same sector in another jurisdiction elsewhere in the basin [21]. For example, the risk of flooding may be different, therefore flood risk reduction may be a priority in one location but not in the other. Diverging priorities can lead to further fragmentation and can potentially lead to conflict without coordinated plans. Similar sectoral fragmentation has been identified within the Ciliwung River Basin. For example, the municipalities of Bogor and Depok have
independent planning systems that are not well integrated, exhibiting fragmentation and limited collaboration [27, 63].

4.3.2  Legal/Institutional

Availability of Legal Frameworks

Across the globe legal instruments dictate the ways water resources are managed [21] and guide the governance of transboundary basins [10]. This may include national laws, regulations, directives or international agreements and treaties [64]. A clear legal framework is suggested to be the basis for successful integrated management [21] and indeed, legal agreements between states often do provide a basis for international cooperative water management [65]. However, in many cases transboundary agreements are still lacking. UNEP-DHI and UNEP [10] found that a large proportion of the transboundary basins across the globe still lack common treaties, or if they do have them, they lack the principles of customary law. They suggest that more effort is needed to negotiate and implement transboundary agreements.

In Indonesia, although the central government created regulation for the implementation of an inter-local-government partnership for the purpose of coordinating local governments, it has been suggested to be too simplistic to tackle the complexity of this task [66]. In addition, each local government is able to decide on its own commitment towards coordination which may also hinder the ability to coordinate successfully between all parties [67].

Enforcement of Regulation

The enforcement of law also needs to be considered, as a law that is not enforced is not effective. Indonesia exhibits a highly bureaucratic legal system, with many different legislative acts and regulations [68]. In relation to flood management, there are several different laws that need to be considered, including the Disaster Management Law (26/2007), the Water Law (07/2004) and the Spatial Planning Law (26/2007). However, several authors have identified that in reality, many laws are not implemented or enforced [18, 43, 68]. For example, Grady et al., [69] identify low levels of compliance with legislation relating to spatial planning and building codes which could impact on disaster risk.

Organisational and Institutional Fragmentation

Many institutions and organisations are involved in flood risk management [64]. Key institutions may include Governments (national, regional, local), utilities companies, private businesses, community groups and insurance providers, among others [7]. Cooperation and coordination are necessary, both between actors at different levels of governance (vertical coordination) and across actors (horizontal coordination).

Vertical Coordination

Within decentralised governance structures, responsibilities for flood risk management may be distributed across various levels from national to local. For example, in a study conducted by the Organisation for Economic Co-operation and Development (OECD), flood anticipation was commonly found to be the responsibility of the national or subnational level, while flood prevention/mitigation and response were common at the local/metropolitan level [62]. Issues can arise where there is a lack of coordination between government levels, which may result in inconsistencies between national and local strategies. For cooperation to take place, it is important that each organisation clearly understands who the other actors are and
how responsibilities are distributed between them to avoid overlapping or duplicated action [7].

In 1999 Indonesia began a process of rapid decentralisation which shifted power from the central government and distributed it to various sub-levels (provincial, city, municipal etc.). However, disconnects between policies at different levels has been observed. It has been identified that provinces lack strategic and operational plans for disaster risk reduction, which creates a policy disconnect with national level [69]. Furthermore, in Greater Jakarta, a lack of clear responsibilities between local, provincial and central government authorities has been identified, hindering cooperation [66]. Overlapping responsibilities have also been identified, for example between BBWSs (river basin management organisations) and PJT (bulk water supply corporation) which has contributed to reduced efficiency and accountability problems [70].

Although responsibility has been transferred to various levels of governance under decentralisation, it has been noted that a similar transfer of power and resources did not occur. The provincial level are found to have limited power which creates a gap between the national level through to the local levels [69]. For example, the provincial disaster management office (BPBD) has the authority for implementation of Disaster Risk Reduction (DRR), but they have not received sufficient resources to act. A lack of funding, staffing and capacity has been found to hinder the work of BPBD [71].

According to Dewi and van Ast [67], there are several regulations in Indonesia that mandate cooperation between governance levels; however, they note that there is little coordination in practice. For example, BKSP (Badan Kerja Sama Pembangunan Jabodetabekjur) is the inter-local government cooperation agency and consults with the central government on development matters. However, BKSP lack the authority to implement and enforce, which means that in reality little coordination actually takes place [61].

**Horizontal Coordination**

As rivers are connected from upstream to downstream, actions taken upstream may influence regions downstream, therefore plans should be co-developed and take into consideration impacts on others sharing the watercourse [4, 8].

As a consequence of decentralisation in Indonesia, authority was distributed across administrative areas. Under Indonesia’s Law of Regional Autonomy (Law 23/2014), each local government has the authority to enact its own regulations, decide on its own priorities and develop its own plans based on local interests [27]. This is often associated with positive benefits as it allows local needs to be met more easily. However, in many jurisdictions local governments have focused on the generation of local revenue. This has resulted in intensive exploitation of local resources [66] that has been conducted with little consideration for neighbouring areas [60, 61]. Local governments were of the opinion that there is no need to coordinate with neighbouring jurisdictions [66]. In some cases, governors have been sceptical about cooperating with others for fear they would interfere in their own administration [60]. This lack of cooperation presents an issue for flood management in the basin. As upstream and downstream reaches fall under different jurisdictions, actors downstream have little say on activities taking place upstream [43]. Indonesia does operate a river basin management system through BBWS (Balai Besar Wilayah Sungai, the river basin management organisation) who act as river basin regulators and as part of this, provide a coordinating function among water use stakeholders [70]. However, it remains unclear from the literature what this entails and whether the system is effective.

**Participation**
Stakeholder engagement in river management is important for the development of solutions that are sustainable and equitable, and to ensure national decisions are compatible with local needs [21].

Governors of Jakarta have for the most part operated a top-down approach to governance which has not involved public participation to any great extent [72]. Although some latter governors have given more attention to participation [60], recent flood management plans, such as those for the construction of the new seawall, have been noted to still lack adequate participation of stakeholders in their design [5]. In general, citizens are excluded from decision making processes [68]. In addition to the attitudes of leaders, socio-economic factors further compound the lack of participation. Poverty, poor education, limited access to services, livelihood profiles and cultural beliefs may affect the ability of people to engage [21, 73].

4.3.3 Operational

Hazard Focused Approaches

The Indonesian Government has implemented structural mitigation measures on a wide scale. This has included dams, flood gates, polders and sea walls. However, this approach to flood management, focused heavily on structural measures, has been criticised for focusing only on the management of the hazard and with little consideration for underlying vulnerabilities [5, 44]. Without proper consideration for underlying risk factors, flood risk cannot be comprehensively addressed.

Furthermore, continued maintenance of existing structural measures is necessary to ensure their continued functionality. Poor management and maintenance of structural measures in some cases has resulted in reduced functionality. For example, due to lack of maintenance of flood retention basins in Jakarta, some now operate at only 30% of their original capacity [69].

Data and Information Exchange

Data and information are crucial to effective integrated water resource and flood risk management. Data and information are required for each stage of the risk management cycle [64], and should include both physical and social aspects [74] for a fully integrated approach. It is clear that for effective management, a variety of data should be brought together.

However, borders can present blockages to the transfer of knowledge, ideas and technologies [75], and a lack of suitable mechanisms for data exchange can pose a barrier to successful transboundary management [58]. For transboundary cases it can be difficult to identify what information exists and therefore what information is required. Information is likely to be held by different actors, which may not necessarily be transparent [76] and may lead to the duplication of data collection. In addition, information may not be easily shared across borders due to use of different technical concepts, languages and terminologies [76]. Actors may take different approaches to data collection and management. Thus it can prove difficult to effectively coordinate data sharing [74].

Climate Adaptation Plans

Climate change contributes additional pressures and compounds existing water management challenges [59]. Thus, transboundary cooperation for river management is particularly important in areas vulnerable to climate change. It is possible that cross-border conflicts could become more frequent as existing arrangements may not be able to handle the strain of future climate change pressures [77]. Therefore, it becomes important that future
FRM plans are robust to deliver effective coordination, but also integrate an element of flexibility to adapt to uncertain future climate changes [59].

A great deal of technical cooperation is likely to be required to develop climate projections, and to formulate plans and make decisions based on the best available evidence. Plans should also be coordinated across the basin to avoid potential knock-on effects and any mal-adaptive practices [78].

5 DISCUSSION AND CONCLUSIONS

The aim of this study was to develop a conceptual framework that brings together the key concepts to be considered for the management of flooding in a transboundary river basin environment, with a particular focus on the Ciliwung River Basin, Indonesia. A diagrammatic summary of the framework is presented in Figure 1. The framework highlights that there are many aspects to be considered in the development of more effective river management plans for the reduction of flood impacts. Firstly, and most obviously, the drivers of flooding need to be addressed. The drivers of flooding can be considered here as ‘external’ and ‘governable’. External drivers concern factors that contribute to flooding but cannot themselves be influenced by improved management. This includes climate and extreme weather, geography, morphology, natural land subsidence and population growth. Governable drivers can be influenced and potentially improved to reduce the likelihood of flooding and the severity of impacts. This includes the way flood management measures are implemented and maintained, land modification, urbanisation, social vulnerability and climate change adaptation considerations. Coordinated action is required to address these factors holistically. There are then other factors which relate to the governance arrangements and approaches themselves. This includes coordination between sectors, institutions and governance levels and the integration of strategies. The effectiveness of management arrangements is also associated with supporting aspects, such as the availability of legal frameworks, political will, technical cooperation, enforcement and participation. These aspects can be used to coordinate activities and integrate approaches so that they are both effective and efficient.

Figure 1: Diagrammatic summary of the conceptual framework.
Through highlighting the key concepts relating to transboundary river governance and flood management, and the potential linkages between them, the framework provides a starting point for investigating how river governance influences flood hazard impacts and how transboundary river management plans may be made more effective in the future in the Ciliwung River Basin.

This study was based on evidence from the literature alone. The project, for which this framework was developed, will go on to collect further empirical data and gain a deeper understanding of the issues outlined above. Future objectives of the project include: the development of hydrodynamic and urban flood models for the downstream Ciliwung River; identification of the existing transboundary management arrangements and levels of coordination and the enhancement of basin-wide dialogue between actors. Although the framework was developed with relevancy to the Ciliwung Basin, it has the potential to provide insights relevant to other transboundary river basins in developing urban and peri-urban environments elsewhere.

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