Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

Article

Transformative flood risk reduction in Jakarta: between urgent needs and contested measures

Matthias Garschagen[1]*, Ayu Surtiari[1], Mostapha Harb[1]

[1] United Nations University – Institute for Environment and Human Security (UNU-EHS)
* Correspondence: garschagen@ehs.unu.edu; Tel.: +49 228 815 0189

Abstract: Jakarta belongs to the cities with the highest flood risk in the world. Its flood hazard is driven by land subsidence, soil sealing, changes in river discharge and increasingly sea level rise. As all of these trends are set to continue, Jakarta's flood hazard is expected to intensify in the future. Designing and implementing risk reduction and adaption measures is therefore of utmost importance. Against the background, the paper draws on a discourse analysis and original empirical household survey data to review and evaluate current adaptation measures and to analyze in how far they describe a path that is transformative from previous risk reduction approaches. The results show that the focus is clearly on engineering solutions, foremost in the Giant Sea Wall project. The project is likely to transform the city's flood hydrology. However, it cements rather than transforms the current risk management paradigm which gravitates around the goal of controlling flood symptoms, rather than addressing their anthropogenic root causes. The results also show that the planned measures are heavily contested due to concerns about ecological impacts, social costs, distributional justice, public participation and long-term effectiveness. On the outlook, the results therefore suggest that the more the flood hazard will intensify in the future, the deeper a societal debate will be needed about the desired pathway in flood risk reduction and overall development planning – particularly with regards to the accepted level of transformation, such as partial retreat from the most flood-affected areas.

Keywords: transformation; flood risk reduction; Jakarta; risk governance

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

1. Introduction

Jakarta is amongst the coastal megacities with the highest flood risk globally (Hallegatte et al. 2013; Hanson et al. 2011). Already today, it suffers from extreme flood events. In 2007, at least 56 died in one of the worst floods in the city's history, in which over 340,000 people had to be evacuated and more than 74,000 houses were flooded (IFRC 2007). The economic damage of that flood alone, which inundated around 60 percent of the city with flooding depths of up to four meters (IRFC 2007), were estimated at around USD 560 million (Wijayanti et al. 2017). Yet, the 2007 flood was by no means a one-off event. Heavy floods also happened, for instance, in the years 2013, 2014 and 2015.

Given the current magnitude and an expected future increase of Jakarta's flood risk (see below), in combination with the ineffectiveness of the existing risk management, radical changes in the city's risk reduction regime are necessary. This need calls for fundamental transformations not only in the built environment and hydraulic infrastructure but also in institutional patterns of risk governance. A first wave of transformational adaptation has been conceived. They are primarily focused on heavy engineering solutions to regulate Jakarta's flood hydrology, leading to substantial resettlement and other – expected or already manifested -- social and ecological side effects. These solutions are therefore heavily contested on the grounds of longer-term sustainability concerns.

Against this setting, Jakarta can be considered a highly relevant case study for the analysis of transformational risk reduction, particularly regarding its enablers and barriers. Whilst conceptual contributions to the debate around transformation have been on the rise over the past years (e.g. Pelling 2011; O'Brien 2012; Pelling et al. 2015), the empirical understanding of how transformation is debated in real-world cases and how it occurs – or not – is still thin (Solecki et al. 2017). The paper aims at making a contribution to tackling this gap.

The next section provides a brief overview over the materials and methods used in this paper. Section 3 then reviews the existing conceptual discourse around transformation in the context of global change research in order to identify key gaps and guiding questions for the Jakarta case study. Section 4 examines the causes for and trends in Jakarta's flood risk – past, present and future. Section 5 introduces the main flood risk adaptation measures currently planned or implemented in Jakarta. Section 6 evaluates the most important measures. Section 7 discusses the results. The last section provides key conclusions and an outlook into future needs for science, policy and action.

2. Materials and methods

The analysis draws on different types of data and methods. Section 3 draws on academic literature to review and assess the current debate with regards to transformation in the context of climate change adaptation and risk reduction. Section 4 draws on existing studies and own analysis of statistical as well as time-series remote sensing data to review and analyze the main drivers of Jakarta's flood risk and their trends. Section 5 draws on a document analysis to introduce the main adaptation measures currently planned or implemented. Section 6 uses published literature and a number of newspaper reports to conduct a brief discourse analysis on the evaluation of the main adaptation measures introduced in section 5. In addition, section 6 draws heavily on own empirical survey data to complement the adaptation evaluation, especially with regards to the social and economic effects on the affected population. The survey data was collected in two survey campaigns

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

in 2014 and 2016, covering 451 households in 2014, out of which 410 have been re-interviewed in 2016 to assess changes over time. The households covered three main groups: First, households being affected by reservoir dredging projects; second, households affected by dyke construction; third, households that have been resettled.

3. Transformation in the context of disaster risk reduction and adaptation

Over the past five years, the notion of transformation has gained considerable traction in science and policy debates around global environmental change (O'Brien 2012). The transformation debate to a large extent originates from climate change mitigation debates. It has been used there to refer to the need for fundamental shifts of the economy, away from its heavy dependence on fossil fuels and other resources such as land and water (WBGU 2011). However, more recently the need for fundamental system shifts are also seen in the realm of climate change adaptation and risk mitigation. One of the main arguments of this debate is that current modes of risk management will increasingly reach their limits in view of future risk trends, which result from the intersecting drivers of climate change and risk-prone socio-economic developments (e.g. urbanization in coasts with high exposure to natural hazards) (Pelling 2011; Solecki et al. 2017; Few et al. 2017; Thomalla et al. 2018). Transformation proponents in this line of thinking argue that the recent surge in the use of resilience concepts can be counterproductive in this context. This is because resilience debates, so the argument goes, tend to concentrate on the persistence and strengths of existing systems and their configurations, whilst sustainable risk reduction is argued to necessitate deep changes of system configurations in many respects (Pelling 2011). A growing body of literature therefore raises concerns that many political and practical initiatives for risk reduction and resilience building concentrate on tackling superficial risk symptoms (e.g. by slum upgrading projects), rather than the deeper institutional root causes of vulnerability and risk (e.g. the political economies that lead to the production and reproduction of marginalization and vulnerability in the first place). Current risk reduction and adaptation efforts therefore have been critiqued to be not sustainable – or even palliative (Ribot 2011). Following this line of thinking, lasting and sustainable risk reduction therefore requires the fundamental transformation of the political economy behind the very production of risk and vulnerability.

Drawing on the context of costal megacities, Solecki et al. (2017), building on Pelling (2011) and Pelling et al. (2015), therefore differentiate between different risk management regimes along a gradient from collapse to resistance, resilience and transformation. The resistance regime is characterized by actors and institutions geared towards keeping the current system and its configurations (e.g. urban morphology) stable, despite increasing external stress, e.g. a rising frequency and intensity of flooding. It implies rising input resources; for instance, protecting the infrastructure and strengthening rigid institutional or bio-physical structures. Resistance often involves conventional engineered solutions with a focus on the built infrastructure, e.g. coastal defense systems – which is of high relevance to the Jakarta context. Resilience entails slight adjustments of the current system to improve its ability to deal with external stress. However, the main system configuration is typically not being questioned. Resilience can rather be understood as

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

an "adjustment at the margins," which ultimately has the aim of stabilizing the core fabric of the system in the face of potential external disturbance. In contrast, transformation is viewed as a form of adaptation that fundamentally questions the setup and fit of current system configurations. The aim of transformative adaptation is to find alternative ways of system configurations that increase the system's long-term sustainability through minimizing risk or rigidity traps, and through establishing co-benefits from new development trajectories. Pelling (2011) argues that a transformation, i.e. the fundamental reconsideration of human-environment relations, will become increasingly necessary in view of growing levels of environmental hazards, stress and perturbation with climate change. He argues that the current focus on resilience-building is therefore insufficient as it does not engage with the necessary yet politically uncomfortable questions of radical changes, e.g. with regards to land use policies, risk insurance configurations or the overall social contract for risk reduction and social protection. By focusing too strongly on the maintenance of current system configurations, resilience-oriented paradigms are therefore argued to run the risk of becoming unattainable in the mid- to long-term future, thus propelling the need for all the more radical adaptation into the future, yet at the expense of increasingly limiting the space for planned adaptation choices. Collapse then refers to the most severe outcome if no adaptation or mal-adaptation is taken, leading to a situation in which the hazard level renders sustaining the system as impossible (Solecki et al. 2017).

A risk management regime is in this line of thinking understood to be describe "an assemblage of policies, strategies, and regulations that collectively define a dominant paradigmatic management approach can be observed in any moment within a city, and that these regimes are a product of climate risk and urban development pressures and in turn will mediate their interaction" (Solecki et al. 2017). Risk management regimes are therefore characterized by the deliberate and conscious as well as non-deliberate ways in which risk is managed. Often, formerly deliberate policy choices and paradigms become deeply entrenched institutionally or culturally, until they are no longer deliberately reflected but rather enacted "automatically".

Solecki et al. (2017) are particularly interested in the transitions between different risk management regimes, i.e. the factors that enable or hinder actors and institutions in a given context to shift from one to the other regime. In this context, they emphasize that shifts towards transformation or other regimes can happen in single sub-systems (e.g. on sector such as transportation) whilst other sub-system remain in other regimes. They can also happen at different scales, e.g. where city governments engage in changing their risk management regime in directions contrasting national policy.

Switches between the different regimes might also be related to turning points in adaptation pathways (Haasnoot et al. 2013; Wise et al. 2014). Protective infrastructure such as a dyke system might, for instance, work until a certain threshold to advance a rigid resistance level. Yet, after the threshold has been reached, the costs of retrofitting might become so high that fundamentally different alternatives might be sought, e.g. retreat from formerly protected areas. Hence, a transformation in risk management would be the result in this example.

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

Yet, apart from conceptual considerations, empirical observations on different types of risk management regimes and the transitions between them remain rather thin, especially with respect to question how changes risk management regimes are contingent on changes in overall development policy (Thomalla et al. 2018). The case study of Jakarta, one of the most flood prone cities globally with extreme adaptation pressure to change current development trajectories, is therefore a prime example for such type of empirical analysis.

4. Jakarta's flood risk: causes and trends

Jakarta's flood risk results from a number of intersecting drivers. First, there is the general topography of the city. Due to the historically good conditions for trade and agriculture, the city developed in the bay of Jakarta, into which the Chiliwung river and 12 other, smaller rivers flow, crossing today's city. Particularly the northern, coastal parts of the city are therefore characterized by a very low-lying topography. Occasional flooding has therefore been an issue since the very early times of today's Jakarta, i.e. the harbor city Sunda Kelapa in the hinduistic Sunda kingdom and the later Batavia, the headquarters of the Dutch East India Company from 1619 onwards (Ward et al. 2013).

However, the flooding problem has been greatly intensifying over the recent decades, mostly due to anthropogenic drivers. First, the city has been experiencing a massive growth in population and economic as well as industrial activity since the second half of the 20th century. Being the capital of Indonesia and its clear center for economic, political and cultural activities (especially during the centralistic Suharto regime) Jakarta's population has grown to well over 10 million today, from around 3 million at the early 1960s. (BPS 2015). Along with this growth, the city has been experiencing an extensive spatial expansion. Figure 1 illustrates this expansion from 1972 to 2014, based on the assessment of remote-sensing time-series data (6 Landsat scenes) through a supervised classification approach, particularly drawing on the maximum likelihood algorithm of the Semi-Automatic Classification Plugin (SCP) for QGIS.

The analysis shows that urban land use within Jakarta's administrative boundary has increased by 276 percent over the last 4 decades, consuming 565 km² of the 674 km² available space, i.e. over 83 percent (Figure 2).

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

189

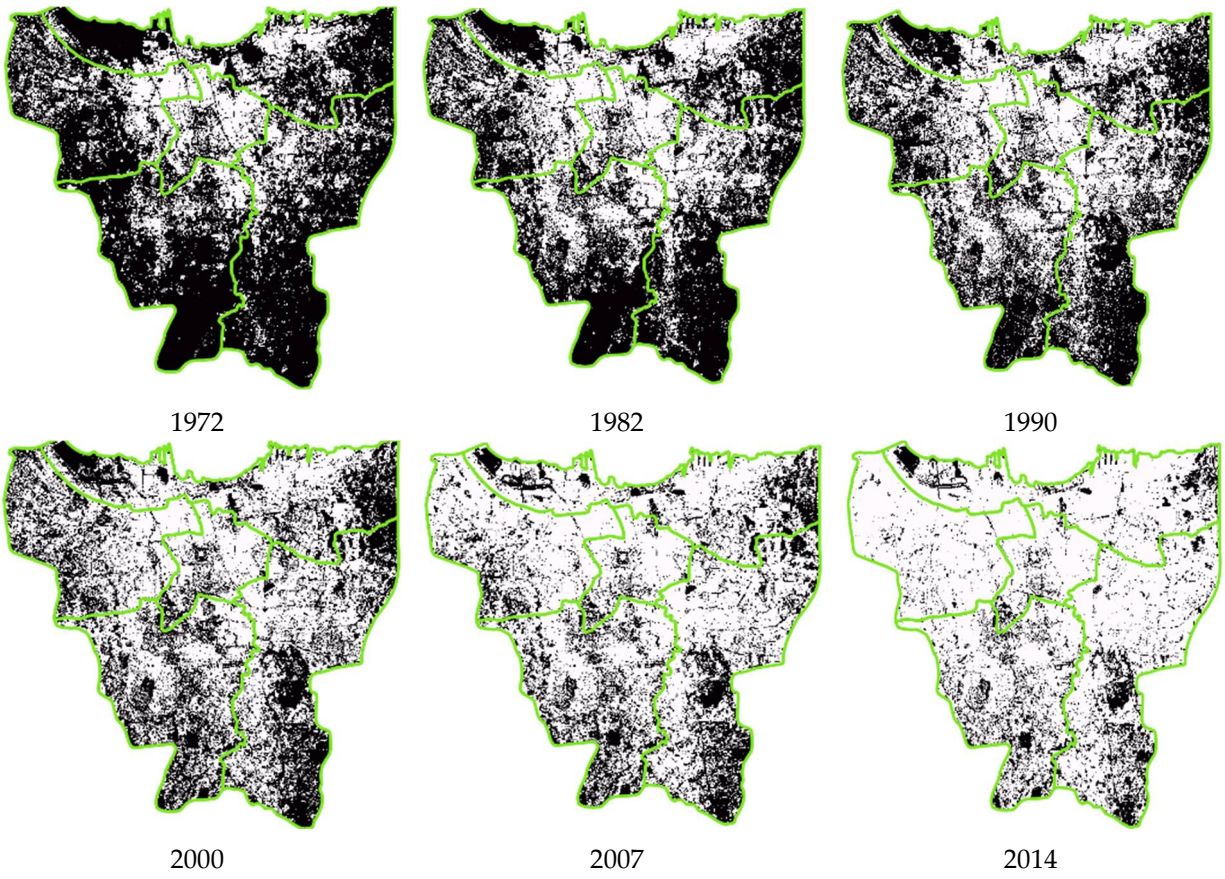

Figure 1: Maps illustrating the urban expansion in Jakarta from 1972 until 2014

190

191

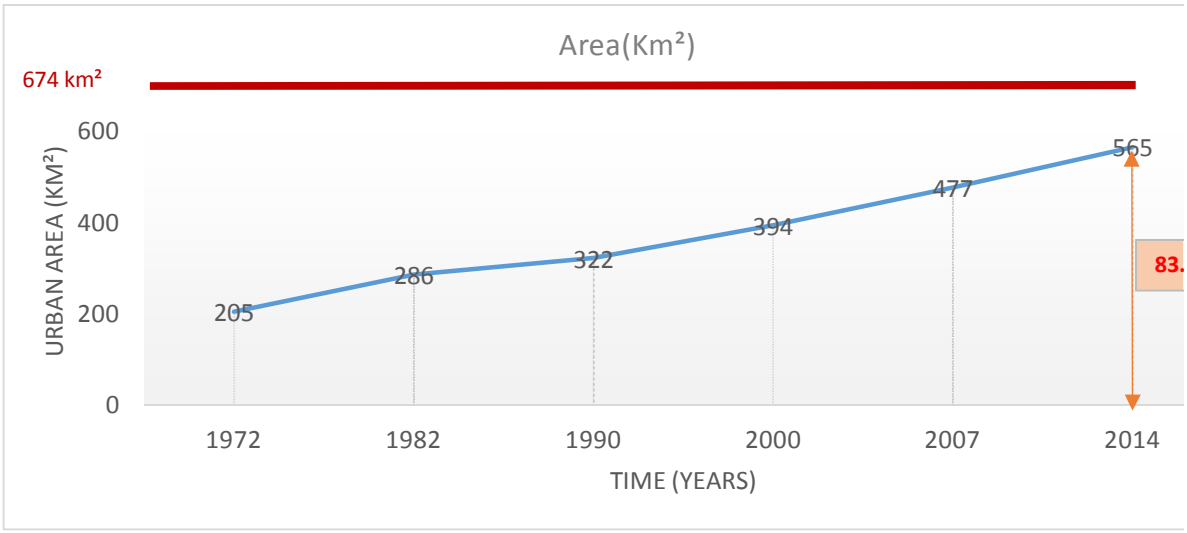

Figure 2: Graph showing the rapid increase of the land consumption in Jakarta administrative boundary from 1972 until 2014

192

193

Along with this increase, the city quickly sprawled beyond its original administrative boundaries, forming an increasingly continuous mega-metropolitan area with formerly separated sub-centers in neighboring regencies (Kapupaten). The mega-metropolitan region has been coined Jabodetabek, in reference to Jakarta's neighbors Bogor, Depok, Tangerang and Bekasi. At the latest census in 2010, this region hosted 27 million people. Also here, a massive land use conversion has been taking place: The built-up are in the Jabodetabek region grew from 65 to 2,015 km² between 1972 and 2012, i.e. by a factor of 31 (Rustiadi et al. 2015).

Along with these massive land conversions in Jakarta and the entire Jabodetabek region, a high number of rivers, canals and wetlands have been built-over, in effect massively reducing flood retention and discharge capacities of the entire region.

The second important factor contributing to Jakarta's flooding problem is the city's significant land subsidence. The rates of subsidence vary across time and space. But some parts of the city have been experiencing rates of up to 25cm per year in extreme periods (Abidin et al. 2015). Long-term measurements reveal that some parts of the city were sinking by a total of up to 4 meters between 1974 and 2010 (ibid.). The most affected areas are largely located within the coastal fringe in the north of the city, i.e. the area anyhow featuring the lowest topography but also some of the highest industrial activity.

Subsidence is driven by three main factors: (1) massive – mostly uncontrolled – groundwater extraction for private and industrial purposes, (2) the natural sediment compaction which is not compensated for due to the lack interruption of natural sedimentation replenishment, and (3) the substantial compaction loads from buildings and other infrastructure (Budiyono et al. 2016). The detailed quantification of these factors' contribution is difficult and a field for further investigation. Nevertheless, most studies agree that the groundwater extraction is by far the most important driver for the observed subsidence.

A third factor contributing to Jakarta's flood risk is the fact that many of the rivers and drainage canals are poorly maintained and clogged with waste and sediments (Budiyono et al. 2016).

On top of existing flooding problems, the city might quite likely experience a further increase in flood risk in the future, as the result of (1) continued growth and land conversion, (2) continued land subsidence, (3) an increase in sea level due to climate change, and (4) an increase in the intensity and frequency of storm and heavy precipitation events. Assuming a business-as-usual progression in sea level rise, subsidence and population growth, modeling suggests that, in the absence of adaptation, the population exposed to a 100-year return period extreme flooding event would rise by 350 percent by 2070, to then over 2.2 million (Hanson et al. 2011).

5. Risk reduction and adaptation measures

Given Jakarta's high current and future flood risk, there question of options for risk reduction and adaptation is pressing. Yet, despite the recent surge in flood risk, this question is not new. Particularly under Dutch colonial rule, the city has seen some quite sophisticated flood protection measures. Soon after the formal establishment of Batavia as the headquarters of the Dutch East India Company in

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

1619, the Dutch started to implement structured canal system in the city, similar to ones in Dutch cities of the time (Caljouw et al. 2005). In addition, a major canal, the so-called Western Canal, was put into service in 1725 to divert parts of the Chiliwung's discharge around the city. This type of infrastructure-based diversions were further intensified in the following years, in an attempt to gain ever more control over the city's hydrology. Integrating these measures into an overarching and comprehensive plan for the entire city, the so-called van-Breens-Plan, named after the project's leading engineer, was issued in 1917, in response to a devastating flood event. This plan comprised major structural measures, including additional diversion canals in the city's west (Western Banjir) and east (Eastern Banjir). The plan's strong focus on engineering solutions provided the major paradigm for other plans to follow over the next decades, notably in 1965, 1973 and 1984 (Caljouw et al. 2005; Ward et al. 2013).

Despite this long tradition in flood protection measures for the city, the extreme event of 2007 lead to a significant intensification of the debate around flood risk reduction and a substantial reconsideration of the respective toolbox – not only in Jakarta but in Indonesia at large (Djalante et al. 2017). This reconsideration has been triggered by the new flooding context, which manifested itself during the 2007 flood. The extreme flood levels of that year had been caused by the confluence of heavy precipitation and discharge with a particularly strong spring tides. Hence, water was pushed into the city not only by the rivers from the south, but also from the sea. This rather new situation shifted the emphasis of flood protection quite drastically: The focus had hitherto been on diverting the discharge of the upstream Ciliwung catchment area around the city and into the sea, the focus now shifted to also include coastal protection, alongside with attempts to expand the retention capacities within the city. As a result, the Jakarta Coastal Defense Strategy (JCDS) was conceived under the patronage of the then governor Fauzi Bowo. The strategy got completed and formerly adopted in 2011.

Since that time, flood risk reduction has been comprising three main groups of measures: First, a strong emphasis has been on the river and canal regulation, the broadening of water ways and the clearance of river banks, which are frequently encroached by informal settlers (Figure 3a). Second, attention has been given to the refurbishment and expansion of flood reservoirs, especially in the city's northern parts (Figure 3b). Third, a major flood protection dam has been under construction along the coast (Figure 3c).

As all of these measures need space, a significant amount of resettlement has been necessary over the past years (Figure 3d). The vast majority of affected dwellings belong to low-income households which had been settling informally on the banks of rivers and reservoirs, given their lacking financial and institutional capital to access land in other parts of the city. The regulation of the Ciliwung alone triggered the resettlement of 15,000 people, i.e. 4,000 households, over the last five years.

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

Figure 3: Pictures showing an encroached river bank (a); the widening of reservoir (b); the construction of a new sea wall (c) and resettlement housing (d)

The Jakarta Coastal Defense Strategy has been continuously revised and expanded since 2011, leading to the so-called National Capital Integrated Coastal Development Masterplan (NCICD) in 2014 (CMEA 2014). At its core, the plan builds on the idea to block the bay of Jakarta off from the sea, by means of a so-called Giant Sea Wall. The project is also known as the "Great Garuda Project" as the project's aerial view resembles the shape of a Garuda, the national bird of Indonesia (see Figure 4). The project has been conceived by a consortium of Dutch and Indonesian planning consultancies, sponsored to a large extend by the Dutch government. Its planned engineering dimensions are quite enormous: The planned sea dyke has a total length of 25 km. Behind it, the former bay shall be converted into a sealed reservoir, the water table of which ought to be regulated so as to remain below sea level in the future, thus allowing for the controlled flood drainage of the city. To achieve this, the largest pumping station installation ever built in one project is planned at a capacity of 730 cubic meters per second in order to pump the water from the reservoir out into the sea (CMEA 2014). In addition, the plan includes upgrades and expansions to the existing flood protection infrastructures in the city, foremost the retention reservoirs, drainage canals, flood protection walls as the main waterways and the coastal dam.

In order to finance these measures, the plan envisages to combine flood protection with the development of new estates for commercial and residential purposes. Within the reservoir massive land reclamation projects are planned to provide space for a new central business district (CBD) and residential area. Together with upgrading planned for the existing parts of northern Jakarta, the plan foresees to generate residences for an additional 650,000 people and attract businesses with 350,000 new jobs (CMEA 2014). In addition, a new harbor and airport are planned toward the east of the embanked area. The total costs of the project are estimated at around 40 billion USD (Win 2017). The implementation is planned to span across three phases with the completion of the sea dyke being targeted for 2022 (CMEA 2014).

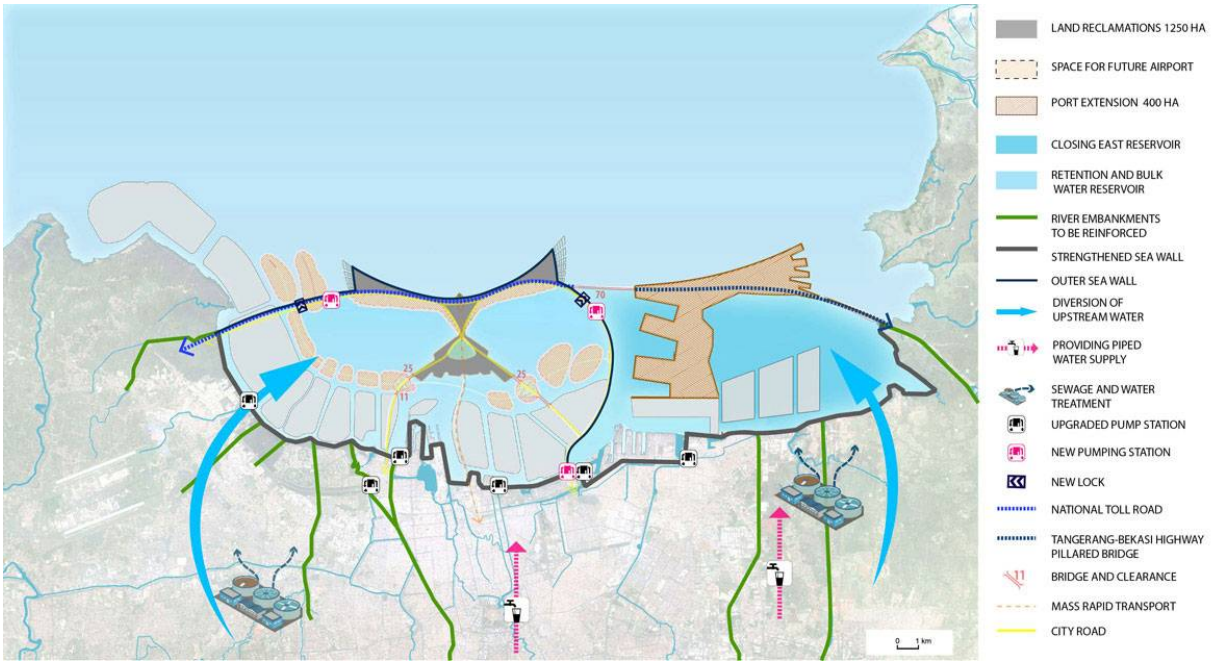

***Figure 4**: Map of the Great Garuda project (Source: www.arbitare.it)*

Next to these formal adaptation measures, flood-affected communities and households in Jakarta heavily engage in small-scale and informal adaptation measures (Marfai et al. 2015; von Voorst 2016; Surtiari et al. 2017). These include individual as well as collective measures, e.g. raising the housing levels, building terraced housing or constructing small-scale water barriers around settlements. However, empirical analysis has shown that these measures are limited in effectiveness to combat the larger floods and their trend towards intensification. The need for more effective, larger-scale flood risk reduction measures governed by formal actors has therefore been stressed (Marfai et al. 2015). Hence, the focus of this paper is clearly on formal measures – yet not devaluing the important role of informal small-scale adaptation and the role it can, in accumulation, play for regime shifts at the larger policy level.

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

6. *Evaluating current adaptation measures*

Given the profound – and potentially transformative – nature of the conceived adaptation measures, questions regarding their evaluation are pressing, spanning across social, economic, ecological and cultural dimensions. Many, if not most, of the currently planned or implemented adaptation measures are greatly contested and have caused heated debates on Jakarta and beyond. Conflict has lately erupted in particular over the Great Garuda project. A major concern, especially of Jakarta's coastal population, is that the embankment is expected to lead to substantial environmental degradation in the bay of Jakarta, thereby causing great damage to local fisheries which provides a major income source for coastal fishing communities. Such worries are backed, for instance, by a study of the Maritime Affairs and Fisheries Ministry, published in 2015. First, the study cautions that the massive embankment through the sea dyke is likely to trap polluted water discharged from the city and its hinterland, hence, contributing to the contamination and, ultimately, eutrophication of the new reservoir (Elyda 2015). Second, the reservoir is expected to trap sediment, hence, leading to a fast sedimentation of the sea bed (ibid.). Third, the new reclamations require considerable amounts of sand -- altogether around 300 million cubic meters (CMEA 2014) – which needs to be pumped largely from the local sea bed. All of the above three effects are expected to have massive impacts on the local ecology and fish stocks, causing ripple-on problems for local fishing communities whose livelihoods depend on them (Elyda 2015). In addition, the sea dyke is expected to even alter local currents to an extent that will cause the erosion of entire islands currently neighboring the planned reservoir (Elyda 2015).

All these concerns have been taken up in fierce political debates. For instance, the promise to stop the project had been a central element of election campaign of Anies Baswedan, the new governor of Jakarta since October 2017. Already in 2016, a moratorium had temporarily stopped the project on the basis of environmental concerns and corruption allegations. However, the moratorium has recently been repealed by the national government, underscoring that conflicts exist not only between different interest groups but also between different levels of government. The future is therefore likely to see conflicts over the issue to continue.

Moreover, criticism is mounting with regards to the perceived social injustice in terms of how the costs and benefits of the project are shared. While the expected benefits of the Great Garuda project, such as the newly developed apartments or the planned business district, will mainly be geared towards middle and upper income groups, the environmental, economic and social costs are largely borne by lower income groups. Overall, our survey data reveals that almost all households which have been directly affected by infrastructure measures (e.g. the coastal protection dyke or reservoir widening) or even needed to be resettled reported a loss of household income. The loss has been most drastic amongst former fishing households who needed to be resettled inland and now have to rely on sporadic and informal income generation.

The repeated survey panels (in 2014 and then 2016 in the same households) also showed the many early hopes in the adaptation measures did not hold the test of reality. Most importantly, while a considerable amount of households expected the adaptation measures to lead to an increase in the self-capacity to deal with future flood hazards, this expectation did not confirm in the second panel. The analysis reveals that a decline in the self-capacity perception significantly correlates with a

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

perceived decline in social cohesion after the implementation of the adaptation measure, particularly in the case of resettlement. Figure 5 illustrates the decline in perceived mutual assistance at the neighborhood level across all three major types of measures.

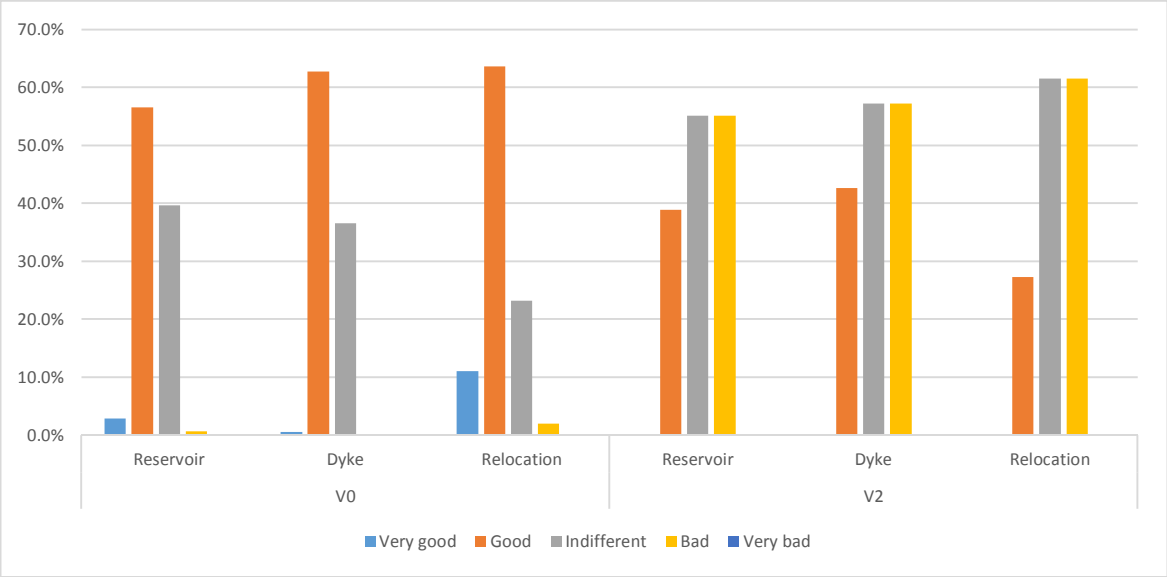

Figure 5: Perceived change in mutual assistance within the neighborhood

Moreover, the survey results clearly show that households affected by formal adaptation measures in most cases felt cut off from information and disempowered and voiceless with respect to the design, planning and implementation of the adaptation measures.

Next to environmental and social concerns, critics also complain that the Great Garuda project only addresses flood symptoms, but does nothing to tackle the major cause of the city's flooding problem: its massive land subsidence (Koch 2015; The Jakarta Post 2015). The project therefore is challenged in two ways, in the eyes of its critics: If the project is implemented without addressing land subsidence, it is doomed to fail as it cannot effectively combat an ever increasing flood risk in the long run, whilst producing a host of negative side effects. Yet, if the land subsidence were to be tackled effectively, the Great Garuda project might prove unnecessary and its negative effects could be averted. At the same time, however, empirical research suggests that experts from Indonesia as well as from abroad doubt that unregulated ground water extraction and, hence, land subsidence could be effectively combated any time soon, due in particular to poor regulation and law enforcement (Colven 2017). Ironically, this skepticisms is used by the project's proponents as one of the main arguments of why the project is necessary, allegedly presenting the best of the remaining options (ibid.).

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

7. Discussion

The empirical observations from Jakarta can make an important contribution to complement and enrich the emerging conceptual debate of transformation, particularly in coastal megacities which are set to experience increasing climate change impacts along with local environmental changes and continued growth. The flooding problem, particularly in northern Jakarta, has been on the rise so severely that the functionality threshold of the city might soon be surpassed. For instance, industrial firms which are clustered in the most flood-affected areas might soon feel forced to relocate, leading to a potential collapse of the industrial sector in this part of Jakarta, with severe implications for the overall development trajectory (Neise et al. 2018). At the same time, the growth and sprawl of the city is set to continue in the future, thus heavily contributing to the further intensification of the city's flood problem, along with climatic changes. The case study therefore shows how closely paradigms of risk reduction are related to policy debates around overall development trajectories and climate change adaptation in those cities.

The experiences of recent flood events, particularly the extreme flood of 2007, have led to a step-change in the way how flood risk management for the city is conceived. The National Capital Integrated Coastal Development Masterplan and its Great Garuda – or Giant Sea Wall – project is the largest of its type ever conceived in Indonesia, perhaps globally. It foresees solutions which are highly transformative in terms of the fundamental changes they will trigger in the city's hydrology and morphology.

However, these changes are not going along with an equal transformation in the way risk reduction is conceived and managed. Rather the opposite is the case: The current measures cement a long-established paradigm of taming nature, in this case flood hydrology, in Jakarta. In that sense, they rather support a resistance or resilience paradigm, bulking the city up against future sea level rise and flood risk. Yet, they do nothing to transform the deeply entrenched development visions and patterns of land acquisition, sprawl and resource exploitation. In particular, they do not engage with one of the main drivers of Jakarta's flood risk problem: the largely unregulated ground water extraction and resulting sinking of the city.

Cynics might therefore argue that – in contrast to statements by many neo-classical development donors and practitioners -- the biggest challenge for transformation is not to be found in the realm of financial or engineering limits but in the changes needed in terms of institutional rules and cultural behavior (e.g. radical changes in ground water regulation and a culture of strict law enforcement).

In addition, the Jakarta case clearly shows that massive engineering-based solutions are also doomed to fail politically and socially, if the costs and benefits are not shared according to the perceived standards of equity and distributional fairness by all affected social groups. The empirical data from our two-time-step household surveys has further shown the importance to consider the long-term livelihood and vulnerability effects for social groups who are affected by secondary effects from adaptation measures. The recent moratorium on the implementation of the Great Garuda project and the fact that the dispute over the project has been a core issue in the latest election of Jakarta's governor therefore shows that the topic of flood risk reduction is no longer a side issue but has arrived at the core of political debate about Jakarta's future.

Peer-reviewed version available at Sustainability 2018, 10, 2934; doi:10.3390/su10082934

8. Conclusions and outlook

Jakarta provides an extreme example of how high the pressure for transformative changes can become in view of growing risks, driven by the confluence of unsustainable development trajectories and climate change impacts. The city belongs to the coastal megacities with the most severe current and future flood risk. At the same time, it is amongst the global leaders in terms planning for bold adaptation measures. In this sense, it can serve as an insightful case study for informing the larger debate on transformation.

The case of Jakarta clearly shows the great social and political challenges that emerge when established development trajectories and their ingrained human-environment relations are reaching the limits of their sustainability and new trajectories have to be sought. The sheer magnitude of the city's flooding problem calls for transformative solutions, which are capable of fundamentally altering the currently engrained modes of development and risk regulation – both of which greatly contribute to the ongoing intensification of the city's flood risk. However, the case of Jakarta also underscores how difficult it is to move from the conceptual calls for transformation to practical solutions in the real world. The analysis clearly reveals that the most challenging hurdle is not to be found in the financial or engineering limits to adaptation. Despite the unprecedented volume of the Great Garuda project, the implementation is currently not being held back by the questions of financing or technical barriers, to which solutions have been found. Rather, the biggest challenge is to be found in the societal and political negotiation of conflicting visions and paradigms for risk reduction, and especially the burden-sharing of negative side-effects.

Looking ahead, the Jakarta case therefore underscores that questions of governance are the main challenge within the field of risk reduction, transformation and development at large. Fundamental transformations in development patterns and risk reduction regimes will be needed in cases like the one of Jakarta in order to enable some sort of long-term sustainability. However, the experiences from Jakarta serve as a clear warning signal that the question of how such changes can be designed and achieved is none to be tackled by technocrats and engineers alone. Rather, they need to be moved into the explicit focus of an inclusive societal debate. This becomes all the more important as risk reduction will increasingly set the boundaries for urban development and sustainability at large, especially in coastal cities exposed to future climate change risks. The Great Garuda project, for example, is designed to provide protection until the year 2080, assuming a mid-range land subsidence and sea level rise over this time-frame (CMEA 2014). Considering the possibility of more rapid trends in both hazards, the threshold could be exceeded already much earlier. Hence, the question whether other, even more transformative, responses such as partial retreat will be needed, tolerated or even actively fostered is only postponed, at most. This question will eventually penetrate the deep tensions between sustaining and letting-go of long-established and cherished urban morphologies and their functions and values. The weighing of different contested options therefore deserves to be pro-actively moved into the spotlight of societal and political debate. It is not a topic that can be solved at the drawing boards of technical experts alone.

Author Contributions: Matthias Garschagen led the discourse analysis as well as the conceptual debate and drafted the manuscript. Ayu Surtiari conducted the empirical household survey and analyzed the data. Mostapha Harb conducted the time-series analysis of urban sprawl and produced the respective figures.

Funding: This research was funded by the German Federal Ministry of Education and Research within the TWIN-SEA research grant.

Acknowledgments: To be added after the review.

Conflicts of Interest: The authors declare no conflict of interest.

References

Abidin, H.Z., Andreas, H., Gumilar, I. and Wibowo, I.R.R. (2015), "On correlation between urban development, land subsidence and flooding phenomena in Jakarta", Proceedings of the International Association of Hydrological Sciences, Vol. 370, pp. 15–20.

BPS [Statistical Office of Indonesia] (2015), Jakarta Province in Figures 2015, Jakarta.

Budiyono, Y., Aerts, J.C.J.H., Tollenaar, D. and Ward, P.J. (2016), "River flood risk in Jakarta under scenarios of future change", Natural Hazards and Earth System Sciences, Vol. 16 No. 3, pp. 757–774.

Caljouw, M., Nas, P. and Pratiwo, M. (2005), "Flooding in Jakarta. Towards a blue city with improved water management", Bijdragen tot de Taal-, Land- en Volkenkunde, Vol. 161 No. 4, pp. 454–484.

CMEA [Coordinating Ministry for Economic Affairs] (2014), National Capital Integrated Coastal Development Master Plan, Jakarta.

Colven, E. (2017), "Understanding the allure of big infrastructure: Jakarta's great garuda sea wall project", Walter Alternatives, Vol. 10 No. 2, pp. 250–264.

Djalante, R., Garschagen, M., Thomalla, F. and Shaw, R. (Eds.) (2017), Disaster Risk Reduction in Indonesia: Progress, Challenges, and Issues, Disaster Risk Reduction, Methods, Approaches and Practices, Springer International Publishing, Cham, s.l.

Djalante, R., Garschagen, M., Thomalla, F. and Shaw, R. (Eds.) (2017), Disaster Risk Reduction in Indonesia: Progress, Challenges, and Issues, Disaster Risk Reduction, Methods, Approaches and Practices, Springer International Publishing, Cham, s.l.

Djalante, R., Garschagen, M., Thomalla, F. and Shaw, R. (Eds.) (2017), Disaster Risk Reduction in Indonesia: Progress, Challenges, and Issues, Disaster Risk Reduction, Methods, Approaches and Practices, Springer International Publishing, Cham, s.l.

Elyda, C. (2015), "Sea wall an environmental disaster: Study.", The Jakarta, 7 October.

Few, R., Morchain, D., Spear, D., Mensah, A. and Bendapudi, R. (2017), "Transformation, adaptation and development. Relating concepts to practice", Palgrave Communications, Vol. 3, p. 17092.

Haasnoot, M., Kwakkel, J.H., Walker, W.E. and ter Maat, J. (2013), "Dynamic adaptive policy pathways. A method for crafting robust decisions for a deeply uncertain world", Global Environmental Change, Vol. 23 No. 2, pp. 485–498.

Hallegatte, S., Green, C., Nicholls, R.J. and Corfee-Morlot, J. (2013), "Future flood losses in major coastal cities", Nature Climate Change, Vol. 3 No. 9, pp. 802–806.

Hanson, S., Nicholls, R., Ranger, N., Hallegatte, S., Corfee-Morlot, J., Herweijer, C. and Chateau, J. (2011), "A global ranking of port cities with high exposure to climate extremes", Climatic Change, Vol. 104 No. 1, pp. 89–111.

IFRC [International Federation of the Red Cross and Red Crescent Societies] (2007), "Indonesia: Jakarta Floods. Appeal no. MDRID003, 26 September 2007", Information Bulletin, Vol. 4.

Koch, W. (2015), "Could a Titanic Seawall Save This Quickly Sinking City?", National Geographic, 10 December, available at: https://news.nationalgeographic.com/energy/2015/12/151210-could-titanic-seawall-save-this-quickly-sinking-city/ (accessed 20 November 2017).

Marfai, M.A., Sekaranom, A.B. and Ward, P. (2015), "Community responses and adaptation strategies toward flood hazard in Jakarta, Indonesia", Natural Hazards, Vol. 75 No. 2, pp. 1127–1144.

Neise, T., Revilla Diez, J. and Garschagen, M. (0), "Firms as drivers of integrative adaptive regional development in the context of environmental hazards in developing countries and emerging economies – A conceptual framework", Environment and Planning C: Politics and Space, Vol. 0 No. 0, 2399654418771079.

O'Brien, K. (2012), "Global Environmental Change II. From adaptation to deliberate transformation", Progress in Human Geography, Vol. 35 No. 5, pp. 667–676.

Pelling, M. (2011), Adaptation to climate change: From resilience to transformation, Routledge, Abingdon.

Pelling, M., O'Brien, K. and Matyas, D. (2015), "Adaptation and transformation", Climatic Change, Vol. 133 No. 1, pp. 113–127.

Ribot, J. (2011), "Vulnerability before adaptation: Toward transformative climate action", Global Environmental Change, Vol. 21 No. 4, pp. 1160–1162.

Rustiadi, E., Pribadi, D.O., Privatisari, A.E., G.S. Indraprahastra and Imam L.S. (2015), "Jabodetabek Megacity: From City Development Toward Urban Complex Management System", in Singh, R.B. (Ed.), Urban Development Challenges, Risks and Resilience in Asian Mega Cities, Advances in Geographical and Environmental Sciences, Springer, Tokyo, pp. 421–445.

Singh, R.B. (Ed.) (2015), Urban Development Challenges, Risks and Resilience in Asian Mega Cities, Advances in Geographical and Environmental Sciences, Springer, Tokyo.

Solecki, W., Pelling, M. and Garschagen, M. (2017), "Transitions between risk management regimes in cities", Ecology and Society, Vol. 22 No. 2.

Surtiari, A.G., Djalante, R., Setiadi, N.J. and Garschagen, M. (2017), "Culture and Community Resilience to Flooding: Case Study of the Urban Coastal Community in Jakarta", in Djalante, R., Garschagen, M., Thomalla, F. and Shaw, R. (Eds.), Disaster Risk Reduction in Indonesia: Progress, Challenges, and Issues, Disaster Risk Reduction, Methods, Approaches and Practices, Springer International Publishing, Cham, s.l., pp. 469–493.

Surtiari, A.G., Djalante, R., Setiadi, N.J. and Garschagen, M. (2017), "Culture and Community Resilience to Flooding: Case Study of the Urban Coastal Community in Jakarta", in Djalante, R., Garschagen, M., Thomalla, F. and Shaw, R. (Eds.), Disaster Risk Reduction in Indonesia: Progress, Challenges, and Issues, Disaster Risk Reduction, Methods, Approaches and Practices, Springer International Publishing, Cham, s.l., pp. 469–493.

The Jakarta Post (2015), "Editorial: Stop Jakarta's Sinking", The Jakarta Post, 10 October, available at: http://www.thejakartapost.com/news/2015/10/10/editorial-stop-jakarta-s-sinking.html (accessed 20.11.17).

Thin Lei Win (2017), In flood-prone Jakarta: Will "Giant Sea Wall" plan sink or swim?, Reuters, Bangkok.

Thomalla, F., Boyland, M., Johnson, K., Ensor, J., Tuhkanen, H., Gerger Swartling, Å., Han, G., Forrester, J. and Wahl, D. (2018), "Transforming Development and Disaster Risk", Sustainability, Vol. 10 No. 5, p. 1458.

van Voorst, R. (2016), "Formal and informal flood governance in Jakarta, Indonesia", Habitat International, Vol. 52, pp. 5–10.

Ward, P.J., Pauw, W.P., van Buuren, M.W. and Marfai, M.A. (2013), "Governance of flood risk management in a time of climate change. The cases of Jakarta and Rotterdam", Environmental Politics, Vol. 22 No. 3, pp. 518–536.

WBGU [German Advisory Council on Global Change] (2011), World in Transition: A Social Contract for Sustainability, Flagship Report, WBGU, Berlin.

Wijayanti, P., Zhu, X., Hellegers, P., Budiyono, Y. and van Ierland, E.C. (2017), "Estimation of river flood damages in Jakarta, Indonesia", Natural Hazards, Vol. 86 No. 3, pp. 1059–1079.

Win, T.L. (2017), In flood-prone Jakarta: Will "Giant Sea Wall" plan sink or swim?, Reuters, Bangkok.

Wise, R.M., Fazey, I., Stafford Smith, M., Park, S.E., Eakin, H.C., van Archer Garderen, E.R.M. and Campbell, B. (2014), "Reconceptualising adaptation to climate change as part of pathways of change and response", Global Environmental Change, Vol. 28, pp. 325–336.