

Design Guidelines for Upgrading Living Conditions in Wetslums



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Abstract The megalopolis of Dhaka, Bangladesh faces, in a larger scale, common issues with the rest of Asian ones and more particularly South Asian ones: a massive population growth leading to urban sprawl on flood-prone areas—more precisely on areas located along the shores or on a water body—mainly in form of slums; named wetslum in this article. However, even if this condition is expected to increase in the next decades, these wetslums have poor living conditions and lack access to basic services. Thus, the purpose of this paper is to propose an approach and guidelines to favor small scale project able to improve wetslum dwellers' living conditions. To do so, the specific issues of these areas which are a shortage of available space, a lack of services due to investment risks and the insecurity of land tenure, are identified along with the position of the different stakeholders involved in these areas. Then, guidelines are set up to bypass these difficulties. Consequently, the findings are used to establish eight constraint requirements that have to be addressed by a wetslum upgrading project proposition: geographic location in wetslum, flood proof ability, flexibility, transportability, standardization, affordability, safety and legality. These guidelines will then be used in a near future to develop a small scale proposition named City App.

Keywords Wetslum · Dhaka · Services provision · Improving living conditions · Flooding

1 Introduction

This paper focuses on Dhaka, Bangladesh, a megalopolis, located in South Asia, that faces the second fastest population growth in the world [1], resulting in urban sprawl on flood-prone areas, mostly in the form of slums [2, 3]. As a result, this city

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is prone to important water related disasters such as floods, windstorms, heavy rain and waterlogging [4]. This situation is likely to getting worse due to climate change. Indeed, Dhaka is the third most threatened city in the world by rising sea level in term of population [5]. Thus, Dhaka will be used as a case study in this paper. Indeed, South Asia, and Asia as a whole face important urban sprawl on flood-prone areas [4]. Moreover, the continent hosts half of the world urban population with no less than 28% of it residing in slums [6]. At the same time, according to a report from the World Bank [7], 38% of the world population lives in highly flood prone zones with 24% of them living in densely populated coastal areas. As a result most of the population and cities settled in flood-prone areas are in Asia which explains the fact that almost all¹ of the water-related disasters observed in the world between 1980 and 2006 are in this region [4].

Yet, this situation is anticipated to continue because of population growth and rising sea level [6, 7]. Indeed, South Asia is expected to double its urban population around 2030. However, most of this population is expected to settle in slums, leading to a massive slum growth likely to take place in flood-prone areas [6]. Thereby, the choice of Dhaka is also motivated by the fact that more than one third of its population lives in slums mostly located in flood-prone areas [2]. Indeed, in the world, urban poor are the most threatened by water-related disasters. This is due to the fact that most of slums are located in the riskiest areas where flood risks, especially prolonged flood are pairing with health hazard, contamination vulnerability, work disruption as well as increasing costs for basic needs, during flood periods, leading to the deterioration of life condition [8–10].

In addition, those slums are confronted to low construction quality combined to the important density in slums as well as to a lack of services, such as waste collection [7, 11]. For instance, in Dhaka no waste collection is made in slums due to access difficulties [12]. Moreover, this situation is likely to increase due to the fact that slums located on or along water bodies as well as on flood-prone areas tend to expand onto the water due to a lack of available space and a lesser risk of eviction [13, 14]. In addition, according to Arachchilage and Jayaratne [15] the level of service provision decreased for the settlements built along or on a water body.

Thus, this specific type of slums or part of a slum, located along the shores or on a water body, where exist a considerable correlation between flooding and living conditions will be defined as wet-slums herein. However, a study made in 2015 [13] highlighted the fact that the dynamic and diverse nature of slums owing to their localization and environment is not taken into account in physical upgrading projects. For this paper, upgrading—more precisely physical upgrading focus on addressing physical issues—is defined as the implementation of functions in a part of slum to improve the level of services. The ultimate goal of such upgrading process is to match the service level existing in the formal part of the city surrounding that particular slum, i.e. integrate slums in cities.

¹Indeed, between 1980 and 2006, respectively 97, 90 and 95% of the world population affected by floods, windstorms, waves and surges where living in this area [4].

As a consequence of the observations made by Olthuis et al. [13], wetslums, where the risks are the highest for the population due to their localization and environment, are less likely to be upgraded with the implementation of services owing to the fact that the ‘classic’ approach used in slum physical upgrading is not set up to cope with water-related disasters [10, 16]. Furthermore, these slums are quickly evolving and expanding while facing increasing disasters in areas with a shortage in available space [2]. In addition, this situation leads wetslum dwellers to turn to what Porio [9] calls a “*water-based lifestyle (p.438)*”, where they get use to regular rise of contaminated water and adjust their daily life in accordance with no conscience about safety risks. Consequently, solutions that overcome this situation are needed and are likely to be small scale intervention, instead of large scale upgrading programs.

Therefore, the aim of this paper is to answer the following question: What approach may be proposed to favor small scale project able to improve wetslum dwellers’ living conditions? To this end the identification of the specific issues faced by wetslums dwellers as well as the stakeholder’s position will be necessary, taking Dhaka, Bangladesh as context. The end goal is to set up guidelines for future small scale project proposition, named City App, able to provide either technical (electricity, sewers, sanitation, water provision...) or social services (schools, clinics, recreational and cultural facilities...) on available spaces and in a short response time in those wetslums in order to improve the long-term living conditions.

2 Identifying Problems Faced by Wetslums Dwellers

Before being able to establish a program of demand for service upgrading in wetslums, it is necessary to define the current context and the specific issues faced by the urban poor living in flood-prone areas. Indeed, as reported by Olthuis et al. [13], the environment and the localization have to be considered in order to provide adapted upgrading projects. In wetslums, issues are mainly connected to floods. As a result it is necessary to understand the reasons of their construction and continuous development as well as the causes of the lack of services and the absence of improvement.

2.1 *A Settling in Risky Areas Due to Land Shortage*

Owing to a lack of available space in fast growing cities, people are forced to settle in high risk areas, especially poor, migrant, refugees and people searching work. According to Hassan [17], the apparition of this situation in those cities follows a recurrent pattern. First, land prices and urban pressure increase drastically and agricultural lands are sold to the poorest and the middle class to support the demand. As a result of this, there is a drastic reduction of available lands and a continuous land price increase forcing the poorest to move to dangerous ecological areas such as flood plains. However, once there, slums dwellers face eviction risk because cities

and States regard these areas as too hazardous or develop infrastructural solutions to provide additional spaces for formal urbanization.

In Dhaka, slum population doubled between 1996 and 2006. In addition, the number of slum communities increased about 70% where the total population grew by 5% [3]. Furthermore, due to the process described by Hassan [17], most of these slums are developed in hazardous zones such as: extremely flood prone areas, open drain areas, dumb site or along the railways. Moreover, these settlements are mainly composed by low quality buildings making them highly vulnerable and fragile [16]. Thus, flood prone areas formerly wetlands, low-lying farms or even water bodies are turned into informal build-area, i.e. wetslums, at an unprecedented rate: 270% between 1975 and 2005 [2]. This phenomenon was mainly taking place between 1975 and 2000 [14]. However, a study from the Centre of Urban Studies et al. [18] demonstrates that population in those hazardous areas will increase more than ever before in the next decades. As a result, in Dhaka, wetslums' population is growing as well as their density and similar situations are observed in fast growing megacities around the world [10–13, 19].

Therefore, most of the slums located in fast growing megacities are developed in flood prone areas and their constant growth lead to an increasing density coupled to a sprawl on water bodies (Fig. 1), caused by a shortage in available land [13]. Because of this, wetslums are facing numerous water-related disasters, such as typhoons, floods, storm surges, heavy monsoon rain and rising sea level, which are, on account of climate change, more and more frequent and stronger [9]. In addition, the development of wetslums is pairing with the destruction and the reduction of cities' natural protection against floods [3]. As a result the main disaster encountered by wetslums dwellers is floods and more precisely long lasting floods [2]. Indeed, prolonged floods generated several health hazards, going from drinkable water con-



Fig. 1 Owing to a lack of space, slums located close to water bodies tend to expand on them. (Above: 2001; Below: 2014) [13]

tamination to mosquitos' infestation and this risk increase in accordance with flood duration which could last several months [8].

2.2 A Lack of Services that Worsen the Threats

Wetslums face an important scarcity of service provision that aggravate the already poor living conditions. For instance, wetslums' growing population increases waste productions which are accumulating onsite due to the absence of proper waste management and collection² [20]. Over and above, existing services usually do not integrate the environmental conditions and the local demand in their conception [21, 22]. Therefore, it could result in an aggravation of the risks during floods [23]. Indeed, sanitation and sewage can overflow when blocked by solid wastes; water taps may be contaminated and social services such as schools or clinics may not be accessible [24]. Moreover, these settlements are often excluded from public-sector resources which severely limit their access to basic services, such as drinking water, sanitation access, education and healthcare services [9, 25].

Furthermore, according to Adebayo and Iweka [26], slums upgrading projects generally do not integrate social services such as library, schools or community centers. However, such facilities have a strong impact in the long term, reducing illiteracy, unemployment and criminality as well as increasing human capital i.e. individual skills, knowledge and ability to work [27, 28]. Moreover, education is crucial to secure household's incomes and increase their safety because it provides better paid jobs and higher savings [25]. Thus, according to Braun and Aßheuer [2], schooling is as crucial as facilities preventing long lasting floods. Indeed, even a basic education is a key to develop financial capital which in result will improve access to other services and better building materials, allowing an improved ability to cope with floods.

Several reasons could explain the shortfall of services in wetslums. One of them is the cost. Indeed, developing specific structures in flood-prone areas is more expansive and requires an expertise in order to sustain floods and secure the investment [10]. In addition, most of the wetslums are seen as temporary by governments due to their localization which means that any investment could be wipe out at any time [13]. Furthermore, the constant growth in population and density lead to quick and constant evolution and expansion of the buildup area as well as a rapid under sizing of services provision [21].

Besides, another reason to this shortage is the fact that wetslums settlements are seen as 'illegal' and hazardous [22]. Because of this, urban poor basic rights to access services and to live safely are commonly denied while they contribute extensively

²As a matter of fact, waste collection issue is common to all slums and in a broader sense to all cities in the developing world [20]. For example in Dhaka, only half of the total wastes are collected [12].

to city's productivity and growth³ [10]. On top of that, there is a perception that wet-slums dwellers are incapable to pay for these services. Yet in most of the cities around the world, urban poor are paying more than the others [7]. Indeed, in the case of electricity provision in Dhaka, the prices are three times higher than the price for people with a legal access [23]. Moreover, before 2016, access to water was either controlled by *mastaan*,⁴ through illegal connections, and sold at a high price or available for free from unreliable tap that were rarely functioning—sometimes just half an hour a day. Such situation is largely due to the absence of involvement from governments concerning services provision in wet-slums [16]. Furthermore, in Bangladesh, low ranking officials collude with the *mastaans* [22]. Thanks to that support, these organizations will hamper any service provisions project in order to keep their business based on outrageous fees for services provision [29, 30]. Nevertheless, the implementation of a proper water supply system in Korail by Dhaka Water Supply and Sewerage Authority (DWASA) [30], proved that this issue can be overcome when the government and the population support the project, and the *mastaans* are the first to benefit from it.

Thus, given the specific context of wet-slums, the implementation of services cannot follow the pattern implemented in other slums upgrading projects [13]. At the same time planners have to find solutions to provide those services and connect wet-slums to the rest of the city while proposing structures easily adaptable and able to answer the needs. According to Brillembourg and Klumpner [31], the best projects in these settlements are the one which are always in progress. However, such project should also be able to cope with evictions.

2.3 *An Absence of Evolution Explained by the Existing Status Quo*

Relatively speaking, the main risk faced by wet-slums dweller is not environmental hazards but eviction [7]. These evictions are officially motivated by the fact that it will reduce population's risk exposure. However, in several occasions, these evictions are made in order to turn the area in new districts or other urban projects [19]. In addition, according to Wendt [32], three other justifications are used by governments: clearing criminality hotspots, avoid health issues to spread to the rest of the city and improvement of city's attractiveness.

When there is no planned project for the evicted area, most of the wet-slums dwellers re-build on the same localization, otherwise they move to another hazardous area [8]. For instance, in Dhaka, wet-slums were first implemented on public owned

³Nevertheless, in Dhaka, slums dwellers could also face a barrier for job opportunity. Indeed, people living in slums are seen as unreliable because they are living in illegal settlements and to bypass this stigma they need an authorization from local-level leader to have a guarantor [22].

⁴According to Ahmed [16] *mastaan* are 'mafia' like organizations in Bangladesh that are working in slums built around political patronage and police support through corruption.

land, but after massive evictions in 2002, they are now settled on low-lying privately owned land destined for urban development [2]. Thus, according to the Centre of Urban Studies [18], about 7% of Dhaka's slums had faced eviction from their present location or were facing this threat. For Degert et al. [12], this threat is due to the refusal from Dhaka's government to recognize slums spreading added to a lack of legal representatives for slums dwellers. However, eviction is not the only approach that has been tried by Bangladeshi Government. Indeed,⁵ resettlements, slums upgrading or even relocation approaches were experimented with various results [33].

Nonetheless, in poor countries such as Bangladesh, resettlements and relocations are actually unrealistic because of cost and shortage in available land [8]. Thus, in the case of Bangladeshi Government, the resulting approach is *"a de facto policy of either "doing nothing" or occasionally demolishing certain squatter settlements without any systematic plan (p.103)"* [25]. Moreover, wetslums dwellers are willing to move only if employment is provided; alternatively they will prefer the status quo even if loans and grant are granted. Additionally, wetslums dwellers not only prefers to stay where they are if recurrent flooding could be eliminated or reduced but also perceive no difference between flood-free areas and sectors facing annual flood [25]. Yet, evictions continue in Dhaka despite a High Court Division of the Supreme Court order, large scale protestations and the actions of the Coalition for Urban Poor (CUP) [8, 22].

Consequently, this insecurity of land tenure endure by wetslums dweller explain why stakeholders, including them, are reluctant to invest in these settlements [22], strengthening the status quo. Thus, no improvements are made to their houses to cope with floods. At the same time, investments from NGOs (Non-Governmental Organizations) are limited for population living in wetslums owing to eviction risk and urban land cost [16]. As a result, NGOs are hesitant to work in wetslums and rarely construct permanent facilities such as sanitation, schools and drainage [22]. Indeed, if an eviction occurs, it will result in financial loss, in regard of the invested capital as well as the investment in staff time and training,⁶ and small NGOs do not have the capital to sustain it.

Therefore, rather than persisting in the status quo, there is much to gain by upgrading these wetslums [7]. Moreover, in Dhaka's case, upgrading slums instead of useless evictions appears to be more realistic [8]. Besides, such programs planned with the purpose to improve wetslums' life conditions and physical environment exist in the

⁵Concerning wetslums upgrading in Dhaka, the political will seems to change with the different governments. Indeed, different improvement programs were initiated by one government and the support of donor agencies at the beginning of the 2000s [8]. Then, eviction continued as reported by Ahmed [16] with the massive eviction that took place in Korail in April 2012. Finally, in 2016, Degert et al. [12] studied an upgrading program supported by another government at this same place.

⁶The second case study presented by Rashid [22] at the page 579, can be an explanation about this reluctance from NGOs. Indeed, this presentation of Agargaon's eviction showcases that Plan International lost all its investments: in running water and sanitation programs as well as healthcare and education ones, made in this 20 years old settlement.

city [23, 30]. Furthermore, Baker [7], report that “*studies show that slum dwellers gain more from slum upgrading than from relocation (p.77)*”. On top of that, in a study taking place in Manila, Ballesteros [10], reports that there is an increasing involvement in favor of wetslums upgrading from local politician since population is willing to pay for the provided services. Ultimately, for Habib [34] and Degert et al. [12], the recognition by the government that slums settlements are part of the city where people live could allow dwellers helped by CBOs (Community Based Organization) and NGOs to manage themselves, initiating a quick improvement of the living conditions [30].

3 Establishing a Small Scale and Flexible Approach Towards Wetslum Upgrading

Now that wetslums’ context and specificities are identified, the stakeholders’ positions and demands toward wetslums upgrading is needed. Then, these information combine with the ones gathered above will be used to define a strategy and listing the constraints that a project located in a wetslum should have to address. Then, several guidelines will be set up for the future City App proposition.

3.1 Positions of the Stakeholders Involved in Wetslum Upgrading

In order to set up the proposed approach, it is necessary to identify the stakeholders involved in such programs as well as their position about it. Thus, several groups of stakeholders intervening in slum upgrading can be identified. In that sense, Alam et al. [29], pinpoint four groups of stakeholders:

- The key stakeholders who are leading programs implementation. This group includes the governments at the national or local level and the different governmental department and agencies [29, 34], in other words the political realm described by Boulding [35].
- The primary stakeholders who benefit from the programs. This group includes the wetslums dwellers, local committees and CBOs. CBOs and committees can be present at the settlement or at the city level such as Basti Basheer Odhikar Surakha Committee (Slum Dwellers Rights Protection Committee BOSK) in Dhaka, a slum dwellers committee organized at the city scale to discuss directly with local governments [36].
- The secondary stakeholders who are directly involved in programs implementation process. This group includes international and national NGOs, local agencies and

private development agency such as CARE [23] as well as international, national and local organizations.

- The tertiary stakeholders who support and advocate the work done by the others groups. This group includes international donor, funding agencies, international institutions and the private sector. Thus this group provides to key and secondary stakeholders funds, expertise, training and technical assistance for upgrading programs due to different success for such programs around the world [30, 37]. As a result, they may support the implementation of such projects but will not be directly involved in it.

Consequently, the proposal will be dedicated to upgrade the life condition of the primary stakeholders. Indeed, according to Rashid et al. [25], wetslum dwellers prefer to stay at their current location, mostly because of the existing social capital, which is quite strong in these settlements in addition to job proximity. Thus, they need access to basic services adapting to the demand and taking the population growth in account⁷ [29]. Moreover, they need to be able to access functioning services during floods periods. However, even if these stakeholders are reliable, responsible and willing to pay to use services, they are nonetheless unlikely to participate in their acquisition [22]. According to Alam et al. [29], this is due to eviction risks and *mastaans* control over existing services which reduce even more their small resources. As a result, communities and CBOs are more likely to run and maintain a project than invest in it. Nevertheless, to do so, they will have to be involved in the process, through their consultation for instance [30, 34]. Hence, in order to maximize the impact of the proposal, these players should be involved in the proposal's realization and implementation process. Furthermore, there is neither accurate database nor real-time data yet necessary to know the type of service required and where it is needed [13]. Therefore, the involvement of the wetslums population, besides the benefit it brings, can provide these data.

Concerning the key stakeholders, a project proposition will have to adapt to their ambiguous vision toward wetslums upgrading. Indeed, as explain before, these settlements are seen as illegal and temporary [13]. Because of this and land ownership issues, bureaucratic regulations and approval systems are long and can be tedious as well as the negotiation to access the land needed to implement the projected services [38, 39]. Thus, the response time for new initiatives can be very long. Nevertheless, beside DWASA [30], different government bodies such as Dhaka City Corporation (DCC), Local Government Engineering Department (LGED) are involved in upgrading programs, with the technical and financial support from tertiary stakeholders [23, 34]. Moreover, Habib [34] reports, page 262, that “*The different government authorities have recently prioritised the need for slum upgrading, due to rapid urbanisation*”

⁷Indeed, page 26, Alam et al. [28] report that upgrading projects are focused on “improving the current situation” and do not take into account the population growth. Because of this the urban poor see these interventions by key and secondary stakeholders as “unfruitful”.

and the deterioration of law and order". Yet, these government bodies have insufficient financial and physical capacity to address services issues. In addition, even if some regulations were changed in order to allow the implementation of services in slums, government and land owners still have the right to evict these settlements [29]. As a result, governments are reluctant to invest in wetslums due to their temporary nature and the costs involved. This lead to the implementation of low cost programs with high maintenance costs [37]. Moreover, these programs are frequently inefficient, do not answer the population needs and could increase the local issues because of the absence of consideration about environmental risks [23]. Thus strengthen these stakeholders' reluctance to invest in such programs. Furthermore, this perception about wetslums temporary nature is even stronger for wetslums located in high value area owned by the government such as Korail. Indeed, this stakeholder will have substantial gain by selling it to let place to waterfront projects instead of upgrading the existing settlement [19, 40]. Over and above, according to Binte Razzak et al. [41] almost 80% of Dhaka's slums are located on privately owned land which implies additional cost for the government. However, this can change when a tertiary stakeholder showcase the benefit of investing in these areas⁸ as well as by making it a condition of its involvement [30]. Thus, to match these stakeholders' demands, the proposition of a project should be authorized by local authorities, flood proof, low cost in its implementation and maintenance as well as match with their perception that wetslums are temporary or prove that it is necessary to improve the overall territory.

Regarding to the secondary stakeholders, it seems that they are the most likely to implement such equipment. Indeed, even if their involvement stays limited in Dhaka due to eviction risks, NGOs play the main role in services provision to wetslums [29, 41]. Thus, the land prices as well as the environmental and eviction risks that limit investment from these stakeholders in wetslums should be address by the proposal. Consequently, the proposition will have to be affordable, flood proof and be able to be preserved in case of eviction. Furthermore, NGOs are involved in different areas such as water and sanitation, health, education, child protection, skill-based training, income generating activities, environment and governance [23, 29], functions that the targeted projects will have to provide. However, the services provided by these stakeholders are implemented little by little without proper assessment, staffing and coordination between them [37, 41, 42]. In addition, most of the time the provided services do not address the wetslums dwellers needs, are frequently selective and the coverage is incomplete, with overlapping services [34, 41]. For Habib [34] and Alam et al. [29], most of this situation is due to stakeholders from the tertiary group: the foreign donors that finance them. Indeed, because of their financing, they have a word to say about the design and guideline of the activities made by the NGO, and their vision is usually not corresponding to the real needs. In addition, the NGOs activities are based on the short term and they could withdraw from their involvement in a

⁸Indeed, in the program lead by the Asian Development Bank and conducted by DWASA [30], the provision of water supply to slums, prevent the reoccurrence of technical and financial issues, unavoidable otherwise.

project when required by their donors [29]. Nevertheless, according to Rachid [22], due to the fact that primary stakeholders are willing to pay for the provided services and able to maintain them, certain NGOs can gain some independence from their donors thanks to the collection of fees for the services they provide. In addition, the initial cost can be recovered in few years [22]. Thanks to this result, the initial amount needed for such initiatives is backed by numerous tertiary players. Therefore, similar initiatives could encourage secondary stakeholders to provide the needed services in the long term while solving the coverage and overlapping issues. Furthermore, in order to collect fees through all the year, the provided service will need to be accessible even during flood periods.

3.2 Determine a Design Strategy for Wetslum Upgrading Projects with the Gathered Information

Now that the problems faced by wetslums and the position of the different stakeholders are identified, a strategy can be developed. To this end, it is necessary to determine the main objective of such projects, in other words identify their beneficiaries, their action and their purpose.

Thus, the main function of such equipment is to improve the living conditions through the provision of technical and social services to primary stakeholders, more precisely wetslums dwellers. Indeed, as reported before, there is an important lack of all kind of services in wetslums. Consequently, a project located in a wetslum will have to achieve its intended goal while addressing the different issues specific to wetslums that prevent such interventions nowadays. The latter are closely linked to the localization of these settlements—i.e. close to water, in flood prone areas or even on water, making them vulnerable to increasingly high and frequent floods and important health risks exacerbate by this lack of basic services.

In addition to flood risk, these settlements are overcrowded, dynamic in nature and face population growth while enduring a shortage of available land, driving to high land prices. As a result, beside the important cost to access to a plot, the guidelines set by NGOs cannot necessarily be achieved due to this lack of space and the need to preserve the facility from floods. For instance, NGOs such as WaterAid implement low cost services in high places to protect them from flooding, however they just consider the previous floods level to select the localization [29]. In such situations, the provided services are not necessarily where they are needed as well as still threatened by higher flood levels.

Besides that, the lack of available space leads the wetslums to grow onto water bodies [13] leading to the “*water-based lifestyle*” describes by Porio, page 438 [9]. As a result, with the wetslums’ extension the services are increasingly distant from where they are needed. Therefore, the parts of a wetslum located and expanding

along the shores or on a water bodies, faced a more important lack of services than other parts of the same wetslum, that are still affected by floods but that are located further away from this water body [15].

Furthermore, wetslums are seen as illegal settlement and perceived as temporary by key stakeholders, leading to a permanent risk of eviction. Moreover, the few existing wetslums service upgrading projects have neither long term vision nor proper assessment and investment, leading to low quality interventions expensive to maintain, vulnerable to high floods and lost in the case of eviction. For all these reasons, investing in wetslums is seen as risky, thus dissuading most of the stakeholders involved in upgrading programs.

Therefore, the resulting design strategy has to provide all kind of services close to where they are needed—i.e. along the shores or on a water body, while being able to cope with water-related disasters and continue to operate when such event occur. At the same time, it has to occupy a minimal space and integrate the dynamic nature of wetslums in order to fulfill its goal with a large impact. For these reasons, such approach should favor replicable proposition. Moreover, it has to be capable to handle eviction risk and thus make investment in wetslums appealing and cost effective for all stakeholders involved. However, to do so, it has to integrate the perception of the key stakeholders toward this type of settlements. In other words, the proposition has to be perceived as temporary. As a result, a project proposition in a wetslum has to be reusable and should be apt to relocate.

3.3 *Developing the Design Strategy by Elaborating Guidelines*

Hence, the resulting design strategy induces different constraints requirements (CR) that a project proposal, to improve living conditions in wetslums, would have to integrate. More precisely eight of them (Fig. 2): be **located** close to where it is needed (CR1) to provide the desired coverage; **flood-proof** (CR2) to cope with the environmental specificities of wetslums; **flexible** (CR3) in its design to adapt to the dynamic nature of such settlements; **movable** (CR4) for this same reason as well as to cope with eviction; **standardized** (CR5) to be easily replicable; **affordable** (CR6) to favor investment in these urban areas; **safe** (CR7) to protect the investment and the local population; **legal** (CR8) to facilitate its installation in a short response time. Furthermore, to guide the conception of such potential projects, it is necessary to detail these constraints requirements. Indeed, thanks to this specific solutions can be pinpointed and then incorporated in a future design strategy.

First of all, it must be located close to the population who will benefit from its services (CR1). However, its installation has to target the available spaces in wetslum. In addition, no destruction and no modifications of the settlement's structure have to be done and the rapid densification and expansion toward water bodies has to be taken into account. Indeed, according to the analysis of aerial images made by

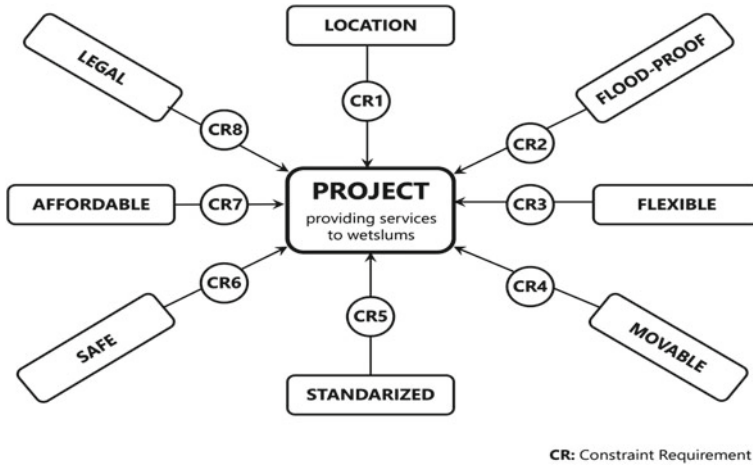


Fig. 2 Besides responding to the desired main function, a project proposition for wetslum has to address different constraint in order to be operational [by authors]

Koen et al. [13] for Korail slum in Dhaka, Makoko slum in Lagos and Isla Verde slum in Davos, water bodies are the only available spaces in wetslums. In addition, these spaces are the ones facing the most important lack of services due to their location [15]. Besides, as expressed by Olthuis and Keuning [43], the solution to space shortage is to build on water to provide more space without interfering with the existing functions.

Furthermore, such project has to be flood-proof (CR2) in order to allow it to sustain floods and different water levels, which are the environmental threat specific to wetslums, as well as to be installed on water bodies. To do so, stilts constructions or floating ones can be considered. However, the solution has to withstand all types of water-related disasters as well as the possibility of constant rising floods levels due to climate change. As a result, floating solution seems to be more fitted than construction on stilts. Indeed, the design proposals made by Altea [24] and Aman et al. [8] proposed floating design for wetslums, located on water bodies, owing to their better performance against these disasters.

In addition, the resulting system has to be flexible and adaptable (CR3) to host all kinds and scales of social and technical services. Moreover, its structure has to be easily transformable and replaceable by another one. For this reason, the different services should be plugged into a unique element that could be installed, transformed and replicated in a short response time as much as being easy to realize. At the same time, this element should allow the implementation of a combination of several similar or different services. Similarly, due to the shortage of existing technical services, the system has to be autonomous utilizing onsite conditions to achieve this. It should also use local materials and knowledge for its realization, in order to involve local population. Thus, it should be a modular solution based on prefabricates

components while involving wetslums dwellers and use local input. For these reasons, the combination of several elements or structures should be considered.

Then, it has to be movable (CR4) to address eviction risks as well as its relocation to a more suitable plot when wetslums are expanding. This confirms the selection of a floating solution. Indeed, construction on stilts cannot be easily moved. Moreover, it has to be able to relocate to another wetslum. Under those circumstances, the system or the element that host the service preferably has to be transportable whole and intact. In that case, its weight and size has to be restricted to favor its portability and the system or the element containing the service should allow its shipping to the desired localization from anywhere.

Hence, the proposal has to be standardized and easy to reproduce (CR5) while offering a sufficient volume to host different types of services. Additionally, the system should use preexisting and standardized elements to favor its portability and reduce its cost. More specifically, these elements have to use existing reusable components, compatible to the existing infrastructures and transportation systems without any modifications, while being easy to combine together. Because of this, the elements have to allow modifications and transformations without interfering with their initial structure to avoid their dismantlement for transport. Thus, the resulting system may be composed of several elements, but the one containing the function should meet all the constraints listed above. As a result, refurbished shipping container appears to be the best match for this requirement of standardization as well as the ones of flexibility (CR3) and transportability (CR4).

Regarding to the safety of this kind of equipment (CR6), it has to preserve the utilities from degradation and water-related disasters as well as allow the system to operate normally when a flood occur. Here again, the selection of a floating solution (CR2) is appealing. In addition, the proposition should provide a shelter and a safe area for its users at any time and particularly during floods periods. Furthermore, it has to be robust to sustain handling during transportation and installation as much as giving it a long lifespan. For this reason, the technical elements composing the different services have to use proven technologies to be resistant and able to work in all conditions.

Concerning the cost, the proposed project has to be affordable (CR7) to match with the demands of the different stakeholders as well as to make it plausible. Here, all the previous constraints serve this objective. Indeed, the flood-proof ability (CR2) preserve the system from water-related disasters and allow it to operate normally throughout the year (CR6), the flexibility (CR3) allow the installation of different function that could be combined and are movable (CR4), thus coping with eviction risks while using standardized (CR5), reusable and robust elements design to have a long lifespan (CR6). Moreover, the proposition should have to use material and components easily available, recycled and mass produced with minimal modifications or not at all. Furthermore, its maintenance has to be minimal and easy as well as its installation and its construction to reduce the costs. At the same time, it has to encourage the local population to participate in its construction and management while leaving them the possibility to own it. In fact, one possible prospect is to make such system available through short term renting to encourage wetslums

entrepreneurs and CBOs that cannot buy it to operate it thanks to renewable short term contracts. These contracts have to be flexible allowing them to easily renew or terminate them. Moreover, to preserve their saving in case of eviction, the contracts are canceled—i.e. they do not have to pay the rent. Ultimately, the overall design of such project should be easy to reproduce or even allow the possibility of its mass-production, at least in theory, allowing cost reduction and higher adaptability for service provision in wetslums in the long term.

Finally, these designs will have to follow different rules and regulations (CR8) to be authorized by the key stakeholders. To this end, its installation in the targeted wetslum has to be accepted and validated by local authorities and must be in compliance with the local regulations and laws regarding what could be applied for it. The purpose is to allow a common validation for the one standard system in the entire city allowing its deployment in a short response time. Moreover, the system or the transportable elements must be certified according to the international transport regulations. This last point supports the selection of refurbished containers.

4 Conclusion

Dhaka, Bangladesh is, like a large part of the megalopolis in the developing world and more precisely like a large part of Asian megalopolis, facing a fast urban sprawl on flood-prone areas. Such urban sprawl leads to the development of a specific type of slums, where a considerable correlation between flooding and living condition exist: wetslums. The specificities of these settlements, defined as wetslums in this article, shown that their establishment in areas vulnerable to water related hazard is due to a shortage in available land that occur in these fast expanding megalopolis. Moreover, because of the important population growth coupled with eviction risks, these wetslums tend to expand on water bodies, leading the dwellers to turn to a “*water-based lifestyle (p.438)*” [9] where they faced increasing floods event and intensity and health hazard.

In addition, there is an important lack of technical and social services in these buildup areas owing to floods and eviction risks that explain, for the most part, why just few investments are made by the stakeholders involved in these settlements. Indeed, the costs for implementing a service able to deal with floods in these areas are higher than in other ones, more protected. As a result, such costs are considered too high for settlements viewed as temporary and illegal by governments. Besides, the insecurity of tenure caused by eviction risks means that any investment made in wetslums can be wipe out at any time when the land owner, that can be private or public decide to retrieve its land. Additionally, even when services are implemented in wetslums, they are frequently inefficient, do not address population’s needs and do not take into account environmental hazards. As a result, even if the position of the different stakeholders is different toward wetslums upgrading, they share a lack of motivation to invest in these areas. However, projects designed to improve onsite living conditions are considered by different studies [7, 8] as the most efficient

solution to achieve this goal and dwellers are willing to pay for the provided services while being quite effective in maintaining and securing it.

Therefore, the proposed approach for a service upgrading project is to improve the living conditions in these settlements through the provision of technical and/or social services to the primary stakeholders by encouraging investment in it. The inclusion of social services, rarely integrated in slum upgrading programs, is motivated by the fact that they have a strong impact on the community's future. However, to achieve these goals, the future design proposition should address the eight constraints requirement identified in this paper to convince future investors. These constraints requirements are the following ones: the localization of the services which have to occupy available space; its flood proof ability to deal with floods and water-related hazards; its flexibility to answer the different local needs; its movability to cope with eviction risks and settlement's expansion; and its standardization, affordability, safety and legality to attract investment. Furthermore, attracting investment can then facilitate the implementation and the development several similar equipment, in a short response time, to any wetslums. To go further, this program of demands could also be used to design replicable structure that can host all the desired services.

Thereby, the result of the guidelines proposed in this paper is a system providing all types of services in wetslum, located on the shores or on water bodies, where the service provisions are the most lacking, (CR1) and thus build on a floating support (CR2) that sustain water-related disasters and allow it to run throughout the year (CR6) while permitting it to move to a new plot if requested (CR4). For this reasons, it has to cope with the local floating or boat regulation (CR8). In addition, it is a modular and flexible system (CR3) based on prefabricate, standardized, transportable and reusable components (CR4, CR5 and CR6). Consequently, in order to comply with all the demands, such system is likely to be composed by two elements: one element that host the requested service and another that constitute the buoyant part.

As a result, an overall concept consisting on providing plug & play floating services without interfering with the existing urban fabric, authorizing fast deployment, upgrade or modification of the requested service in order to respond to the specific needs of a targeted wetslum, as long as needed, may be the end goal of these guidelines. Therefore, the future development of such concept, named City App, will be developed with the approach and the guidelines established in this article.

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