World Academy of Science, Engineering and Technology
International Journal of Urban and Civil Engineering
Vol:14, No:11, 2020

Knowledge Integration from Concept to Practice: An Exploratory Study of Designing a Flood Resilient Urban Park in Viet Nam

To Quyen Le, Oswald Devisch, Tu Anh Trinh, Els Hannes

***Abstract*—**Urban centres worldwide are affected differently by flooding. In Vietnam this impact is increasingly negative caused by a process of rapid urbanisation. Traditional spatial planning and flood mitigation planning are not able to deal with this growing threat. This article therefore proposes to focus on increasing the participation of local communities in flood control and management. It explores, on the basis of a design studio exercise, how lay knowledge on flooding can be integrated within planning processes. The article presents a theoretical basis for the structured criterion for site selection for a flood resilient urban park from the perspective of science, then discloses the tacit and explicit knowledge of the flood-prone area and finally integrates this knowledge into the design strategies for flood resilient urban park design.

***Keywords*—**Analytic Hierarchy Process, AHP, design resilience, flood resilient urban park, knowledge integration.

I. Background and Research Questions

A. Traditional Planning and Flood Mitigation Planning in Vietnam

THE formal planning of landscapes in Vietnam can be divided into three main branches: 1) overall socio-economic development planning (on a national to local level); 2) spatial planning (including land use and master planning); and 3) sector planning. In general, the planning framework envisions that the lower-level plans should follow the directions laid out in the upper-level plans. However, experience shows that, in reality, this workflow is often broken up, and planning processes are rather disjointed and characterized by synchronizing low-level between the vertical and horizontal sectors [1]. Moreover, a lack of financial support from government and provincial budgets are obstacles to the monitoring, maintenance, improvement, design, and funding of flood control projects [2]. In the context of the general urbanization, management, and planning challenges in Vietnam, climate change has increased the pressure on local urban governments, with inefficient planning often exceeding their capacities and resources.

To Quyen, Le is with the Faculty of Civil Engineering, Ton Duc Thang University, Ho Chi Minh, Vietnam and is with the Faculty of Architecture and Arts, Hasselt University, Hasselt, Belgium (corresponding author, phone: 84-937031090; e-mail: letoquyen@ tdtu.edu.vn).

Oswald Devisch and Els Hannes are with the Faculty of Architecture and Arts, Hasselt University, Hasselt, Belgium (e-mail: oswald.devisch@uhasselt.be, els.hannes@uhasselt.be).

Tu Anh, Trinh is with the University of Economics Ho Chi Minh, Institue of Smart City and Management (e-mail: trinhtuanh@ueh.edu.vn).

In the period from 1970 to 2000, Vietnam experienced 5858 storms, 4859 floods, and 1310 disasters; thus, flooding is the most important issue facing Vietnam [2]. According to the available statistics, Vietnam has approximately 5000 km of river dikes, 1000 km of estuary dikes, and 2000 km of sea dikes that provide protection against flooding. Dike rehabilitation and infrastructure construction is a fundamental strategy for flood mitigation in Vietnam [2].

Ho Chi Minh City (HCMC) has witnessed a very rapid urbanization by attracting an increase in the number of migrants from rural areas. After reunification in 1975, the population has doubled 5.17 million people by in 2000 [3]. In 2019, the figure has accelerated to 8.598 million [4]. The urbanization and traditional planning have affected the urban form of the city, urban spatial development, followed by real estate market dynamics; it is not surprising that local governments struggle to deal with this.

In Vietnam, all the strategies for flood mitigation have been developed and are being used to cope with floods. A key challenge for Vietnam is to manage its (rapid) urbanization in a sustainable manner and to prevent the adverse impacts of environmental degradation and climate change caused by flooding [5]. Environmental consideration in the policy planning process has therefore recently changed towards environmental sustainability and resiliency planning.

B. Introducing Flood Resilient Urban Parks

The resilience approach should contribute to ecological sustainability. Long-term resilience is built on resilient natural systems, which acknowledges that flood resilience is built on the existing water systems, floodable lands and natural floodplains [6]. With this focus, adaptation is used in this paper to refer to increased design resilience [7]. Flood Resilient Urban Parks (FRUP), for instance, "provide a range of environmental, social, cultural, education and economic functions while integrating flood adaptation infrastructural strategies" [8]. For example, a reservoir could temporarily store a large volume of rainwater and provide outdoor activities for local people, such as paddleboats, fishing, and sightseeing. As such, FRUPs could advance socio-ecological systems and challenges in conventional planning in Vietnam.

The limits of adaptation planning in Vietnam might consist of purely state-centred formal mechanisms. The point of departure of this paper is that in the application of these measures, local communities living and working in flood-prone areas should be involved in water management. The

question is how to implement concepts such as FRUPs within the context of Vietnam. FRUPs are in a situation that is suffering from a combination of an increase in flooding and a process of rapid urbanization but does not have the planning tradition or capacity to deal with the speed and scale of these processes.

C. Integrate Knowledge in the Design Process and the Role of Knowledge Integration

Acquiring explicit, implicit and tacit knowledge can also facilitate a process of combining this knowledge with expert knowledge. Tacit knowledge could consist of tradition, inherited practices, implied values, and prejudgements, which is a crucial part of scientific knowledge. Tacit knowledge, also known as local knowledge, can play a transparent, democratic, effective, and efficient role in the urban planning process [9]. The design process is being asked to focus on the knowledge-to-practice gap, to increase the involvement of multi-stakeholders. It is clear that knowledge integration has a critical role during design process. More work is needed to understand the role of tacit knowledge in decision-making and practice. For instance, the involvement of local communities introduces a challenge of knowledge integration; equally important however is the balance of explicit and tacit knowledge entire design process.

To consider knowledge integration in the context of design education further, we can look at the SECI model as an approach to this challenge. In addition, the SECI model also brings the theory to practice, which is reflected throughout the 8 steps of the design process. According to the SECI model, a process of Socialisation, Externalisation, Combination, and Internalisation converts through a series of tacit and explicit interactions [10]. Knowledge creation is a cycle of tacit and explicit exchanges via four modes, which include socialization (from tacit to tacit knowledge), externalization (from tacit to explicit knowledge), combination (from explicit to explicit knowledge) and internalization (from explicit to tacit knowledge) (see Fig. 1).

Fig. 1 A design process through explicit and tacit knowledge [11]

This article specifically focuses on the modus of externalization. Externalization is a process of articulating tacit knowledge into explicit concepts based on the findings from socialization. According to Nonaka and Takeuchi externalization happens naturally by working and collaborating together. However, experience shows that in reality, externalization often stops at step 4, at the transformation from tacit knowledge to explicit knowledge. Experiential knowledge as a part of tacit knowledge is perceived to be important for design because the use of

experiential knowledge and tacit knowledge can provide valuable data and can verify theoretical conjectures or observations [12]. The problem is that experiential knowledge cannot easily be made explicit because it is contrary to practices of justification and lacks recognition in research. Scientists (experts) become more specialized and more removed from tacit knowledge; hence, the distance between scientists and the community also increases in the context of climate change [13]. For instance, scientists want their knowledge translated into action through expert engineering solutions without relying on other types of knowledge such as societal interest and nature. When the managers get consultant from specialist who do not clearly understand the local context, it risks for city because the governs made decision without real-life situation context, for example conducting the ecological response of the wetland is not inappropriate with the hypothetical flooding scenarios [14]. According to [13], the 'knowledge–action paradox', which is what scientists take for granted and is one kind of 'tacit knowledge' within the scientific community, may conflict with the immediate experience and 'tacit knowledge' of lay people.

Knowledge integration has provided many opportunities to create networks and collect a large amount of data that can constantly be updated, which is aimed at improving urban planning. The level of integration can occur in different degrees based on a real situation. For example, distinctions are made between multi-disciplinary and interdisciplinary research in landscape ecology [15]. Examining knowledge in this way highlights that the criteria used to compare knowledge types are often not distinct and/or overlap [16]. To integrate and interact between local and expert knowledge is a challenge in a design process. Generally, we can explore abstract concepts through concrete criteria, cope with defined problems and build bridges between experts and laypeople.

D. Aim and Research Questions

This research hypothesizes that the improvement of mutual understanding by experts and local communities of flooding challenges in Vietnam would enhance the success of actual realization. This paper aims to (1) disclose the tacit and explicit knowledge of a variety of actors on flood-prone area and (2) integrate this knowledge in order to be able to apply it to concepts such as FRUPs. This overall aim is further operationalized into the following research questions:

- Analysis 1: Which issues do (or don't) all actors (e.g. experts and laypeople) that operate in flood-prone areas focus on?
- Analysis 2: Which of these issues, do these actors view in a similar way?

In this paper, we focus on the empirical case study of Thanh Da, Binh Thanh District, HCMC. We first present the general approach of the method. Four major steps and four types of knowledge are interpreted by quantitative and qualitative evidence. The case study aims to understand the (physical) flooding issues that the Thanh Da is facing and identify the challenges that current planning processes have in addressing these challenges. The article will specifically focus on the challenge of defining criteria to select locations for the development of FRUPs. The criteria should gaze at the FRUP as the activities to the needs of the local community, the local water system as well as the national and local flood mitigation. Therefore, the FRUPs have balanced the conceived activities related to the needs of the local community; the flood-mitigation potential of the FRUP depends on the degree to which it is integrated into the local water system. Consequently, it requires the integration of expert and lay knowledge. This paper presents a theoretical basis as the analysis criterion for a FRUP from scientific knowledge, then discloses the tacit and explicit knowledge of the flood-prone area from expert knowledge, on-site knowledge and laypeople knowledge and finally integrates this knowledge into the strategies for FRUP design in Thanh Da practice.

II. Method

A. General Approach

This section will discuss the methodological steps that were taken in order to formulate answers to the research questions. This paper is based on a theoretical and explorative research. An online survey was conducted with 12 spatial planning experts and a community of 292 lay people was approached with semi-structured interviews.

Externalisation is not an easy process. Its challenge is in how a knowledge owner can effectively articulate their possessed knowledge into a written document. Thus, it can be shared by experts and lay people to become the basis of new knowledge. So, it requires a process of four steps, namely gathering, validating, consolidating, and synthesising criteria to select locations to develop a FRUP. In the gathering step, we identified and defined selection criteria based on a literature review. In the validating and consolidation steps, we developed a hierarchy among these criteria on the basis of the interviews with experts and the local community by defining links and relationships. In the consolidating step, we started coding the criteria. Coding is an iterative process in which we explore ideas and meanings embedded in data. This step resulted in three groups of criteria, in line with the two research questions: (i) which selection criteria are of importance to both the experts and the local community, (ii) which criteria are of no importance to any of the actors, and (iii) which criteria are of importance to some of the actors. The fourth step as synthesizing criteria as 'knowledge integration' in order to find out if these actors view in a similar or different way.

B. Four Types of Knowledge

1) Scientific Knowledge

Scientific knowledge is one of domain knowledge in design and all fields of study. The use of scientific knowledge is to solve problems or reach goals. A systematic literature review provided a theoretical basis of criteria for the site selection of FRUPs. This knowledge takes the form of codified knowledge found in documents, databases such as professional knowledge and scientific publications. The central research

question for the systematic review was: What is the current scientific evidence for the site selection of urban parks/urban green space?

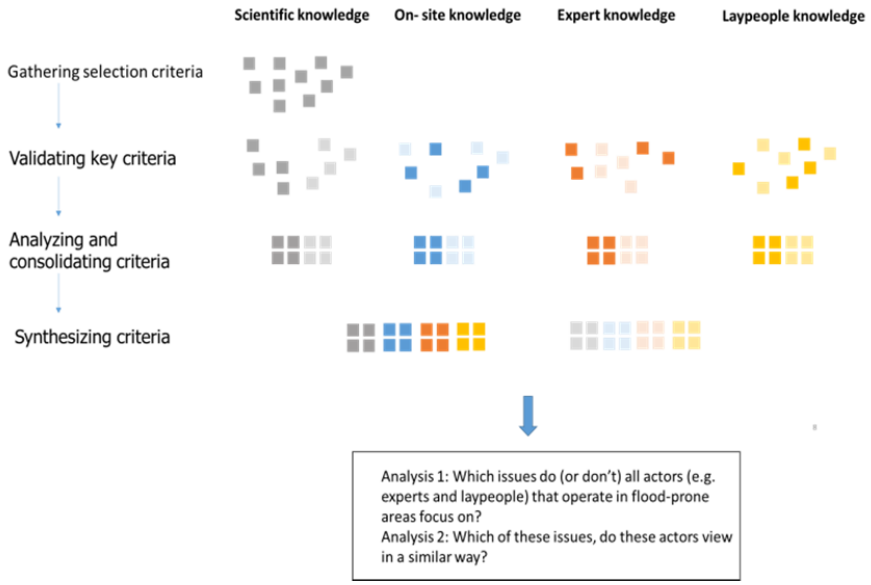

Fig. 2 Model of Methodology

2) On-Site knowledge

An understanding of the site and its environment is an essential part of a design process. Site analysis is a research activity that focuses on the existing and potential conditions on and around a research site. These data are then analysed in terms of their implications for the development of the site for the stated purpose. A first step is to identify the factors and then analyse each factor's potential impact on the proposed development. On-site knowledge is contained in written and visual documentation (explicit knowledge). It provides insights in the resources and environmental features, which consist of strengths, opportunities, weakness, and threats, in order to deal with the environment and socio-economic problems.

3) Expert Knowledge

Knowledge is possessed by experts in a particular domain. The term 'experts' in this paper refers mainly to urban planners, yet also includes architects, engineers and governors who are specialized in planning. Expert knowledge reflects a depth of experience, which may or may not have been derived through structured and formalised processes [17]. It is characterised by research or explicit use of reflection in practice [16]. Typically, experts have many years of experience and practice. Much of experiential expert knowledge is tacit, and some can be made explicit.

Expert knowledge typically implies the interviewing of experts in order to explore their experience and their perspective. However, technical assistance from experts must be balanced. Too much influence of experts over a process can lead to a decrease in participant empowerment and their trust in the outcome [9].

4) Laypeople Knowledge

This knowledge is often linked with the concept of local knowledge in verbal communication and not in any codified or written form. The potential of tacit knowledge for better urban planning can be easily demonstrated by noting that the people living in a specific environment own the true experience of local dynamics and know the needs around them better than anyone else. Locational information provided by laypeople could help design more effective strategies to tackle (flooding) issues.

III. Results

A. Gathering Selection-Criteria

This step was conducted by systematically putting all relevant literature content in Fig. 3 to create an overview. The structuring criteria include 4 criteria groups, 11 criteria, references, and a general description. The criteria are collected due to the popularization of the geographic information system (GIS) for site selection in the urban green space suitability [18], [19], urban park at local scale [20], local forest park [21]. Urban parks have demonstrated to provide benefits relevant ecosystem services to urban citizens [22]. Most of criteria are relate to GIS field but food providing criteria.

The set of criteria are categorised in four criteria groups including the social, economic and biophysical. The outcome will provide for a theoretical basis that will support the subsequent steps.

B. Validating Key Criteria

1) Validating Key Criteria on Scientific Knowledge

Scientific knowledge has been known for being private work, in which scientists take place only in their own groups

within a research sphere [23]. A scientific knowledge role, aims to encourage knowledge dissemination, knowledge reuse, expert localization, and collaboration. Using knowledge in other disciplines and applying it is really a new challenge in the way of transferring new knowledge. Most of the criteria in this paper relate to the GIS domain, however, we have boldly introduced other criteria from the field of environmental science and the practical understanding of the research context. One of the criteria is food providing that reflects the degree of impact on food providing by nature. This criterion which is found in environmental science provides benefits relevant to ecosystem services to urban citizens, such as providing food [24]. Another criterion is the land donation which is added learning from fieldwork and expert knowledge relating to people who accept to donate land when the construction site is on their house or property.

Criteria group	Criteria	References	Description
Physical	A. Existing water surface	(Li et al. 2018)	Reflects the conditions of water resources and maintenance of the ecological balance
	B. Access to road	(Tahmasebi et al. 2014)	Characterizes the basic conditions of traffic Distance to access roads
	C. Landform	(Teimouri & Yigitcanlar 2018)	Reflects the degree of impact slope and elevation on living
	D. Soil	(Teimouri & Yigitcanlar 2018)	Reflects the stability of the development of soil
Biological	E. Vegetation cover	(Teimouri & Yigitcanlar 2018)	Reflects the degree of impact on vegetation distribution, the stability of the development of green space
	F. Food providing	(Buchel & Frantzeskaki 2015), (Millennium Ecosystem Assessment 2005)	Reflects the degree of impact on food providing by nature
Economic	G. Local economy	(Salehnasab et al. 2016)	Reflects the degree of local dependency
	H. Land use	(Li et al. 2018), (Salehnasab et al. 2016)	Reflects the ecological value of land resources
	I. Land donation		Reflects the degree of local people accept compensation cost or donate own land to move out the other place.
Social	J. Tourism resources	(Li et al. 2018)	Reflects the development degree of tourism resources and facilities
	K. Cultural and historical value	(Salehnasab et al. 2016), (Millennium Ecosystem Assessment 2005)	Distance to cultural and historical places Sense of community and aesthetic appreciation

Fig. 3 Theoretical Basis

2) Validating Key Criteria on On-Site Knowledge

The Thanh Da peninsula is located 8 km northward of District 1 (the city centre of HCMC) and is surrounded by the Saigon River (Fig. 4). This area is the only remaining natural island in HCMC, covering almost the entire area of Ward 28 in Binh Thanh District, with an area of 426.93 ha and with 13.360 inhabitants. The topography of the area is plain consisting of only flat lands. The area has an important function as a flood prevention reservoir for the rest of HCMC. The closeness to water in combination with the generally underdeveloped agriculture has challenged Thanh Da to cope with floods due to tides and heavy rains.

Fig. 4 Thanh Da Peninsula, Binh Thanh District, HCMC, Viet Nam

In 1992 the city has commissioned a masterplan for Ward 28 including residences for 4000 households, namely the Binh Quoi–Thanh Da Ecology Urban Development. This plan was never developed. At the end of 2015, a joint venture of Bitexco Group and Emaar Properties PJSC (Dubai) was appointed by the HCMC People's Committee as the investor of the Binh Quoi - Thanh Da. The project duration is 50 years from the date of signing the contract. However, the project has been suspended to date. There are still more than 3,000 households living with the project since 1992. The area was earmarked for the long-stalled development for 27 years while thousands of locals are still living in dilapidated houses and are not allowed to build new houses.

Ironically, the master plan had initially been considered too ambitious and impractical but became outdated shortly after approval [25]. The plans fall short of the sufficient applicability to cope with the issues pointed out earlier in this paper, such as the rapid urbanization and climate change. According to Hoang Minh Tri, the deputy director of the HCM Institute for Development Studies, the main problems are land clearance and compensation [26]. The initial development cost was estimated to be $1.35 billion, of which approximately $979 million would be used for land clearance, and $310 million would be used for infrastructure construction. Fig. 5

applies the selection criteria, defined on the basis of the literature study, to the case of Thanh Da.

Criteria group Level 2	Criteria Level 3	Significant evidence
Physical	A. Existing Water Surface	The closeness to water together with generally underdeveloped agriculture. The site has several existing canals and, depending on how they incorporate in the built environment, they can be excavated to connect.
	B. Access to road	Binh Quoi Street is the only main road on the peninsula The rest of the internal roads are mostly gravel/unpaved roads with narrow roadways built not according to road standards.
	C. Landform	The topography of the area is plain or flat lands. Land elevation is below 2.0 m and common elevation is 0.5 m.
	D. Soil	There are signs of erosion at some point on site Through the analysis, 430 households can be affected by landslides around the riverbank.
Biological	E.Vegetation cover	More rural and natural area with agricultural land, wetlands known as the "city garden" in HCMC.
	F.Food providing	Orchards, bananas, fish and Nypa fruticans from the natural product but not many.
Economic	G. Local economy	Two-thirds of people are based on service and trade as a fishing resort, restaurant, or small business; One-third of people are farmers.
	H. Land use	Land prices vary greatly from agricultural area to urban area
Social	I. Tourism resources	Community- based tourism ecologically and a cheap price service.
	J. Cultural and historical	Retaining the native values and local traditions can farm their greens and fishing.

Fig. 5 The Socio-Economic and Environmental Characteristics on Case

3) Validating Key Criteria on Expert Knowledge

On the basis of the on-site knowledge collection, we decided to slightly alter the selection criteria before presenting these to the experts. Namely, we added the sub-criterion 'land donation', referring to people who agree to donate land when the construction site is on their property. For this article, 12 experts were interviewed representing different stakeholder groups within Vietnam and from foreign countries. An online questionnaire of the project "FRUP site selection" was directly emailed to them via the link https://bpmsg.com/academic/ahp-hiergini.php?sc=gUvugu (present in Appendix section). On the basis of this extended list of selection criteria, we formulated an online questionnaire asking experts to weight the criteria. To obtain the relative importance of factors, they are paired for comparison. The method, which combines qualitative and quantitative attributes, may help to discover the relevant criteria for a new structural concept of FRUPs. The Analytic Hierarchy Process (AHP), introduced by Thomas Saaty since 1980, is an effective tool for dealing with complex decision making from non-structure to hierarchical structure, and may assist to set priorities and make the best decision [27]. The AHP techniques aim to reduce complex decisions to a series of pairwise comparisons within criteria or between pairs of criteria. The AHP helps capture both subjective and objective aspects of a decision making. In addition, the AHP valuate the consistency of the matrix. It accepts some small inconsistency in decisions (i.e., 10%). Pair wise comparison matrix obtained by decision maker must satisfy Saaty's Consistency Ratio condition,

$$C.R = \frac{C.I}{R.I} < 0.1$$

As the result, the consistent ratio: CR = 6.8% < 10% and weight calculation results are acceptable.

As Fig. 4 illustrates, the highest important criterion by experts is the physical criteria at 0.395. The most significant criterion that experts consider is vegetation cover (19%); next are existing water surface (14.7%) and landform (11.5%) as essential elements; and soil (5%), food providing (4.6%) and local economy (3.9%) are the unimportant elements (Fig. 6).

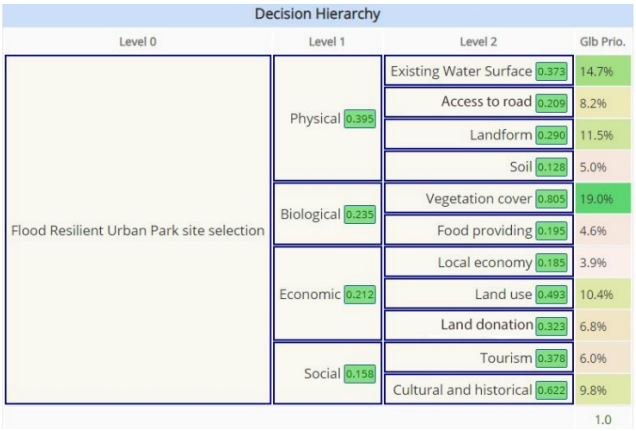

Fig. 6 Results from criteria after expert evaluation

4) Validating Key Criteria on Lay People

We used a semi-structured interview to understand how the local community of Thanh Da approaches the selection criteria

defined on the basis of the literature review. Fig. 7 summarizes a series of statements that relate to particular criteria. The findings investigate what criteria they suggest and in the nature of their expected activities, and the data generated within all groups and ages are presented. The following are the meaningful responses; local interests are a key concern.

Issues emerging from the data analysis are categorized into four main criteria groups:

(1) Regarding the physical group, people feel strongly about the potential of FRUPs to mitigate flooding and about the ability to use FRUP as part of accessible road network;
(2) Regarding the biological group, a green space plays a very important role for their community, and they also appreciate the role of greenery in their lives. The potential of a FRUP to provide food is not considered by any of the respondents;
(3) Regarding the economic group, tacit knowledge revealed very little. Profitable activities, such as commercial fishing, are the most common attractive activity, but people do not link such economic activity to the idea of a park. Land donation is a critical challenge for the majority of respondents, who did not agree with moving to another place;
(4) Regarding the social group, the residents agree that cultural and historical values can be an economic resource, itself creating a reason for tourists to visit.

Criteria group Level 2	Criteria Level 3	Significant statement evidence	Result from questionnaire
Physical	A. Existing Water Surface	"Big river transmits water from the inside out estuaries and then lead to the small canals. If the water level is higher than the canal level, we pushed up ground to prevent flooding issues."	
	B. Access to road	"Why don't we renovate the roads and build dikes instead of the urban park to cope with flooding?"	
	C. Landform	"My house is lower than the road surface so it is flooded. I cannot elevate the ground floor because my house height is too low; I have to use pumps during emergencies."	
	D. Soil	"The soil used to be good agriculture, but now it is not productive, so I did not cultivate anymore."	
Biological	E. Vegetation cover	"I like to live here because it has a lot of green space. By looking out of the windows, the green space is everywhere." "Just go deep inside, you will feel cool and breathing is easier."	Of the respondents, 84.5% consider natural green space to be important or very important. A high percentage of respondents also stated fresh air (20.3%) as their main motive for visiting urban parks.
	F. Food providing		Regarding the most unexpected activities, animal husbandry (61.4%) are disagree and strongly disagree activities in the park.
Economic	G. Local economy		Regarding the most unexpected activities, commercial fishing (43.8%) and are disagree and strongly disagree activities in the park.
	H. Land use	"I don't live anywhere else because the house for rent is a cheap price."	
	I. Land donation		A high percentage of respondents, more than 57% in this study, disagree for compensation, 29% agree and Of the respondents, 15% have no idea. Similar results were found for land donation criteria; 70% disagree, 16% agree and 14% have no idea.
Social	J. Tourism resources		Regarding the most expected activities, the tourist (62%) are strongly agree and agree.
	K. Cultural and historical	"I like to live here because the environment is pure, cool and quiet. I like living here and going to work elsewhere."	Regarding the most expected activities, the tourist (64,7%) are strongly agree and agree.

Fig. 7 Laypeople knowledge evidence

C. Analyzing and Consolidating Criteria

To develop a spreadsheet for explicit and comprehensive findings of qualitative studies, in this step we compare all the previous steps and, as such, integrate knowledge gained from literature review, on site analysis, expert questionnaires and local community surveying. In concrete we combined Fig. 8 for structure, we can begin with the criteria group – criteria – as a core focus, with two categories: focus (a +) and not focus (a–). The focus has strong evidence in science, socio-economic and environmental features, local statement and the Glb priority from experts is higher than 10%. In contrast, the not focus has weak evidence in science, socio-economic and environmental features, local statement and the Glb priority is lower than 10%.

D. Synthesizing Criteria

Analysis 1: Which Issues Do (or Don't) All Actors (e.g. Experts and Laypeople) that Operate in Flood-Prone Areas Focus on?

In light of the constructed database of categories as presented in Fig. 8, synthesizing criteria can be proposed. Among the possible analyses are the resulting classifications in light of the following question: Which issues do (or don't) all actors (e.g. experts and laypeople) that operate in flood-prone areas focus on? There are three themes, in line with the first research questions: (i) which selection criteria are of importance to both the experts and the local community, (ii) which criteria are of no importance to any of the actors, and (iii) which criteria are of importance to some of the actors (Fig. 9).

Criteria group	Criteria	Scientific Knowledge	On-site knowledge	Expert knowledge	Lay people knowledge
Physical	A. Existing water surface	+	+	+	+
	B. Access to road	+	+	_	+
	C. Landform	+	+	+	+
	D. Soil	+	+	_	_
Biological	E. Vegetation cover	+	+	+	+
	F. Food providing	_	_	_	_
Economic	G. Local economy	+	+	_	_
	H. Land use	+	+	+	_
	I. Land donation	_	+	_	+
Social	J. Tourism resources	+	+	_	+
	K. Cultural and historical value	+	+	+	+

Fig. 8 Knowledge evaluation

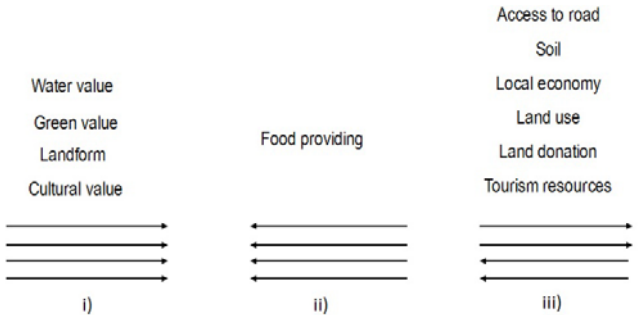

Fig. 9 Themes emerging from the data analysis

Existing water surface, Vegetation cover, Landform, Cultural and historical value are the most important criteria to both experts and the local community. An analysis of the findings showed that natural value and cultural values are commonly referenced (e.g. "scenic attributes", "aesthetical experiences", "green value"), while under ecological benefit and values education (e.g. "opportunity to learn about the environment by observation or experimentation", "learning from direct experience of nature") as food providing in park are the most commonly unidentified. There are six criteria, including access to road, soil, local economy, land use, land donation, tourism resources, of importance to some of the actors.

Analysis 2: Which of These Issues, Do These Actors View in a Similar Way?

There are three themes in which all actors that operate in flood-prone areas focus on. The question we want to investigate here is: Which of these issues, do these actors view in a similar way? As a result of the overall analysis of the way that actors view for each issue, it is a similar and different lens of the issues. For instance, the existing water surface criteria, which are of importance to both actors, seem to be a commonly used criterion. This criterion reflects the conditions of water resources and maintenance of the ecological balance, such as water quality, water quantity, and distance to water [21]. In contrast with social knowledge, evidence about the existing water surface is also related to the role of the advantages and disadvantages of the water area as a threatening factor that was described by the local residents during interviews. Local residents recognize the importance of water as a solution to reduce flooding. The advantage of a water system exists, but a water system can also be a barrier due to distance to a river, a place with historic flooding. Similarly, for the vegetation cover criteria, the consulted experts consider diversity, distribution, and density as main criteria for site selection [21]. However, local residents do not envision such complex technical criteria; they only consider the comfort for users because of the fresh and comfortable air. Experts mainly think about technology and engineering as a fundamental solution whereas the community considers user's satisfaction. These are two criteria that look similar but manifest in two different ways.

Cultural and historical value criteria are characterized as embedded knowledge. These criteria reflect a sense of community and aesthetic appreciation, and people respect the native values and the local tradition. Cultural criteria are also regarded as being the most valuable source of knowledge. Cultural criteria are one of the social criteria groups and the resource of physical criteria, namely, what is visible on the surface. What is culture? The question is as common as it is difficult. Many people can benefit from public green spaces because of their accessibility, such as an indicator of the distance to cultural places [21]. However, a broad benefit of cultural value is greater in ecosystem service [24]. These values include aesthetic, cultural heritage and historic, biological diversity, recreational, spiritual and religious, and place-based values [28]; these values could be a combination of water index, vegetation index, or road index, for example. Knowledge integration has great difficulty in handling this type of knowledge. The physical and cultural groups are the most important criteria for landscape design.

Providing food is the only criterion that is neither scored by experts nor by lay people (-) meaning that it is of no importance to any of the actors. However, the potential to provide food, such as crops of sunflower and rice fields, draw excess nutrients from the water and makes the landscape productive and educational in Houstan Park, China, which is a good example of a floodable park.

In all, there are 6 criteria of importance to either experts, on site observants or lay people. These criteria recognize the most distinct group because there are many different opinions between focus and not focus. The gap and disparity of knowledge types are also the highest. Therefore, spanning this gap requires the approach of measurement to define the problem and to find the cause of their differences and their connections. In general, from the results, on-site knowledge always has a (+), which shows that on-site knowledge has value when the other knowledge is ambiguous or unclear. All economic groups' criteria are missing in this theme, which shows that people and experts think that FRUPs do not need economic activities in general. The local economy in Thanh Da is distinctive, but it does not manifest in the people's desires, which may be a flaw in the way we share information and ask questions. FRUPs have the potential to include both benefits to visitors and income opportunities for nature tourism service providers.

IV. Discussion

The findings of this survey contributed to a better understanding of different types of knowledge on FRUPs in Thanh Da fieldwork. This study examined evidence from both quantitative and qualitative information impress by strong and weak evidence performance. The findings investigate two analyses to demonstrate which issues all actors (e.g. experts and laypeople) that operate in flood-prone areas do (or don't) focus on and the way they view issues. Distinctly, all knowledge is a mixture of tacit and explicit elements rather than being one or the other [27]. Nevertheless, in order to understand this mixture, it is important to make the contradictions explicit among the constituting knowledge, such as the theoretical and expert opposites, the observed context and laypeople opposites, etc.

As a result of the two analyses of the classifications made for each example, it is possible to inaugurate some findings regarding the strategies related to each type of issues. For the group criteria are importance to both the experts and the local community, a translation to further design should be seen to integrate local knowledge into existing water systems (to later support infrastructural strategies) and existing socio-economic dynamics (linked to water). There are both strong and weak evidences of the issues. One way to validate data contributed by the public can be by using IT assistance, such as map overlays with expert knowledge to check spatial congruency [30], [31]. For effectively surveying the status quo, fieldwork can be conducted with experts. Collecting experiential knowledge from designers and architects in in Architectural Design Education has been an approach implemented to integrate experience knowledge into design [32]. The experiential knowledge from specialists should be a main driver when the lay people knowledge is not embraced. The recommendations should be integrated from expert knowledge (innovative activities and facilities) into cultural value (linked to water). However, the increasing complexity of the design process makes experience competency insufficient as the key component for knowledge-supporting design [14]. A transfer of expert knowledge and on-site knowledge could be a main driver when there are many gaps among the different types of knowledge. "Design is not about creativity, it is about problems" [33]. Field studies must take into account the domain knowledge of the design disciplines involved and facilitate feedback loops from the ongoing design processes. Visual aids increase the interest of receivers and help the givers to easily explain the concepts [34]. Regarding to economic issue, the design strategy should integrate on-site knowledge into local economic development based on tourism service. Field studies play a critical role in acquiring contextual and human-centred knowledge from social interests. Hence, "Knowledge acquisition results from individual participation and interactions with tasks, technologies, resources, and people within a particular context" [35].

Appendix

Questionnaire to Experts

AHP Scale: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2, 4, 6, 8 values in-between).

With respect to FRUP site selection, which criterion is more important, and how much more on a scale 1 to 9? (Fig. 10)

	A - wrt Flood Resilient Urban Park site selection - or B?		Equal	How much more?
1	Physical	Biological	1	2 3 4 5 6 7 8 9
2	Physical	Economic	1	2 3 4 5 6 7 8 9
3	Physical	Social	1	2 3 4 5 6 7 8 9
4	Biological	Economic	1	2 3 4 5 6 7 8 9
5	Biological	Social	1	2 3 4 5 6 7 8 9
6	Economic	Social	1	2 3 4 5 6 7 8 9

Fig. 10 Criteria of FRUP site selection

With respect to Physical, which criterion is more important, and how much more on a scale 1 to 9? (Fig. 11)

	A - wrt Physical - or B?		Equal	How much more?
1	Existing Water Surface	Transportation	1	2 3 4 5 6 7 8 9
2	Existing Water Surface	Landform	1	2 3 4 5 6 7 8 9
3	Existing Water Surface	Soil	1	2 3 4 5 6 7 8 9
4	Transportation	Landform	1	2 3 4 5 6 7 8 9
5	Transportation	Soil	1	2 3 4 5 6 7 8 9
6	Landform	Soil	1	2 3 4 5 6 7 8 9

Fig. 11 Sub-criteria of the physical group

With respect to Biological, which criterion is more important, and how much more on a scale 1 to 9? (Fig. 12)

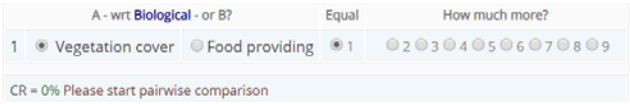

Fig. 12 Sub-criteria of the Biological group

With respect to Economic, which criterion is more important, and how much more on a scale 1 to 9? (Fig. 13)

Fig. 13 Sub-criteria of the Economic group

With respect to Social, which criterion is more important, and how much more on a scale 1 to 9? (Fig. 14)

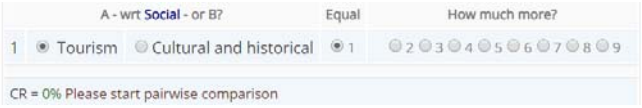

Fig. 14 Sub-criteria of the Social group

ACKNOWLEDGMENT

We thank Hasselt University for assistance with ideas and contributions, and Ton Duc Thang University for financial support that greatly improved the manuscript.

REFERENCES

[1] J. Birkmann, M. Garschagen, F. Kraas, and N. Quang, "Adaptive urban governance: new challenges for the second generation of urban adaptation strategies to climate change," *Sustain. Sci.*, vol. 5, no. 2, pp. 185–206, 2010.

[2] K. W. Pilarczyk and N. S. Nuoi, "Experience and practices on flood control in Vietnam," *Water Int.*, vol. 30, no. 1, pp. 114–122, 2005.

[3] P. L. Vo, "Urbanization and water management in Ho Chi Minh City, Vietnam-issues, challenges and perspectives," *GeoJournal*, vol. 70, no. 1, pp. 75–89, Sep. 2007, doi: 10.1007/s10708-008-9115-2.

[4] Statistical Office in HCMC. 2018. Annual books of the year 2018. Ho Chi Minh City (VN): HCMC.

[5] Asian Development Bank, "Vietnam: Environment and Climate Change Assessment," ADB, Mandaluyong City, Philippines, 2013.

[6] K.-H. Liao, "A Theory on Urban Resilience to Floods–A Basis for Alternative Planning Practices," *Ecol. Soc.*, vol. 17, no. 4, p. 48, 2012.

[7] O. Moura Rezende, A. B. Ribeiro da Cruz de Franco, A. K. Beleño de Oliveira, A. C. Pitzer Jacob, and M. Gomes Miguez, "A framework to introduce urban flood resilience into the design of flood control alternatives," *J. Hydrol.*, vol. 576, pp. 478–493, Sep. 2019, doi: 10.1016/j.jhydrol.2019.06.063.

[8] T. Q. Le, O. Devisch, and T. A. Trinh, "Flood-resilient urban parks: Toward a framework," *Area*, p. 6, Mar. 2019, doi: 10.1111/area.12543.

[9] S. D. S. Pulles, "Tacit Knowledge Use in Spatial Planning via ICT: A Study into Digital Collection and Integration Potential," Master's Thesis, 2017.

[10] I. Nonaka and H. Takeuchi, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press, 1995.

[11] L. Whelan, C. Maher, and C. Deevy, "Towards a University Design School. Restoring the value of tacit knowledge through assessment," *Des. J.*, vol. 20, no. sup1, pp. S1459–S1470, 2017.

[12] K. Niedderer and L. Reilly, "Research practice in art and design: Experiential knowledge and organised inquiry," *J. Res. Pract.*, vol. 6, no. 2, pp. E2–E2, 2010.

[13] J. Naustdalslid, "Climate change–the challenge of translating scientific knowledge into action," *Int. J. Sustain. Dev. World Ecol.*, vol. 18, no. 3, pp. 243–252, 2011.

[14] I. Fazey, J. A. Fazey, J. G. Salisbury, D. B. Lindenmayer, and S. Dovers, "The nature and role of experiential knowledge for environmental conservation," *Environ. Conserv.*, vol. 33, no. 1, pp. 1–10, 2006.

[15] G. Tress, B. Tress, and G. Fry, "Clarifying integrative research concepts in landscape ecology," *Landsc. Ecol.*, vol. 20, no. 4, pp. 479–493, 2005.

[16] C. M. Raymond, I. Fazey, M. S. Reed, L. C. Stringer, G. M. Robinson, and A. C. Evely, "Integrating local and scientific knowledge for environmental management," *J. Environ. Manage.*, vol. 91, no. 8, pp. 1766–1777, Aug. 2010, doi: 10.1016/j.jenvman.2010.03.023.

[17] T. G. Martin, P. M. Kuhnert, K. Mengersen, and H. P. Possingham, "The power of expert opinion in ecological models using Bayesian methods: impact of grazing on birds," *Ecol. Appl.*, vol. 15, no. 1, pp. 266–280, 2005.

[18] Z. Li, Z. Fan, and S. Shen, "Urban Green Space Suitability Evaluation Based on the AHP-CV Combined Weight Method: A Case Study of Fuping County, China," *Sustainability*, vol. 10, no. 8, p. 2656, Aug. 2018, doi: 10.3390/su10082656.

[19] R. Teimouri and T. Yigitcanlar, "An approach towards effective ecological planning: Quantitative analysis of urban green space characteristics," *Glob. J. Environ. Sci. Manag.*, vol. 4, no. 2, pp. 195–206, 2018.

[20] E. Tahmasebi, M. Jalali, M. Gharehghashlo, M. Nicknamfar, and H. Bahmanpour, "Urban park site selection at local scale by using geographic information system (GIS) and analytic hierarchy process (AHP)," *Eur J Exp Biol*, vol. 4, pp. 357–365, 2014.

[21] A. Salehnasab, J. Feghi, A. Danekar, J. Soosani, and A. Dastranj, "Forest park site selection based on a Fuzzy analytic hierarchy process framework (Case study: the Galegol Basin, Lorestan province, Iran)," *J. For. Sci.*, vol. 62, no. 6, pp. 253–263, 2016.

[22] S. Buchel and N. Frantzeskaki, "Citizens' voice: A case study about perceived ecosystem services by urban park users in Rotterdam, the Netherlands," *Ecosyst. Serv.*, vol. 12, pp. 169–177, Apr. 2015, doi: 10.1016/j.ecoser.2014.11.014.

[23] J. Oliveira, J. de Souza, R. Miranda, and S. Rodrigues, "GCC: An environment for knowledge management in scientific research and higher education centres," *Proc. -KNOW'05*, pp. 633–640, 2005.

[24] M. E. A. Millennium Ecosystem Assessment, *Ecosystems and human well-being*. Island Press Washington, DC, 2005.

[25] D. Huynh, "The misuse of urban planning in Ho Chi Minh City," *Habitat Int.*, vol. 48, pp. 11–19, Aug. 2015, doi: 10.1016/j.habitatint.2015.03.007.

[26] J. Breuste, J. Schnellinger, S. Qureshi, and A. Faggi, "Urban ecosystem services on the local level: urban green spaces as providers," *Ekologia*, vol. 32, no. 3, pp. 290–304, 2013.

[27] M. Alavi and D. E. Leidner, "Knowledge management and knowledge management systems: Conceptual foundations and research issues," *MIS Q.*, pp. 107–136, 2001.

[28] B. Burkhard and J. Maes, "Mapping Ecosystem Services," *Adv. Books*, vol. 1, p. e12837, Mar. 2017, doi: 10.3897/ab.e12837.

[29] J. Maes *et al.*, "Mapping ecosystem services for policy support and decision making in the European Union," *Ecosyst. Serv.*, vol. 1, no. 1, pp. 31–39, Jul. 2012, doi: 10.1016/j.ecoser.2012.06.004.

[30] A. M. Salama, "A theory for integrating knowledge in architectural design education," *ArchNet-IJAR Int. J. Archit. Res.*, vol. 2, no. 1, pp. 100–128, 2008.

[31] S. A. Gregory, *The Design Method*. Springer US, 1966.

[32] A. Arcidiacono and B. E. A. Piga, "Visual simulation and large projects evaluation," in *Congresso AESOP/ACSP-Bridging the divide: celebrating the cities*, 2008, pp. 1–15.

[33] P. T. Thuc Anh, C. Christopher Baughn, N. T. Minh Hang, and K. E. Neupert, "Knowledge acquisition from foreign parents in international joint ventures: An empirical study in Vietnam," *Int. Bus. Rev.*, vol. 15, no. 5, pp. 463–487, Oct. 2006, doi: 10.1016/j.ibusrev.2006.05.004.