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'We are not afraid of flooding' …but what about landslide? The effects of assumed and perceived hazards on the value of residential locations*

The issue of interest is as to whether it is possible to use the added value generated by the positive effect of having housing developments close to water to abate the negative effects that may arise in some of the same locations. This paper is based on a critical literature review together with expert interviews. It comments on the methodology of spatial benefit-cost analysis (benefit for price premium 'generated' by the amenity; costs for price discounts 'generated' by the risk) in relation to design of housing and hazard management mechanisms within the context of urban land use in contemporary Trondheim, Norway. The particular issue at stake concerns potential quick clay landslide hazard areas. Prior research suggests that the role of situation by a coast, lake or river should not be overlooked when assessing possibilities for financing general water related hazard abatement schemes. This is potentially a win-win-situation: safety enhancing public works could be financed based on the added value of new developments at the given location. The purported kind of innovative financial mechanism however requires close cooperation between private developers and local authorities – in other words, governance instead of government – as well as flexible legal codes. Unfortunately the study area to a great extent lacks such institutional possibilities due to an outmoded conceptualization of the role of government intervention.

Key words: *attractiveness, hazardous effect, housing developments, quick clay landslide, water*

1. Introduction

On 27 March 2008, a landslide disaster took place in Ålesund, a picturesque coastal town in central Norway, resulting in loss of life. Elsewhere, between 1987 and 2002 large flood events took place around Europe, the greatest frequencies of them being in north-western Romania, south-eastern France, central and southern Germany and the east of England, respectively (ESPON Atlas 2006). In fact, the respective issues of landslide and flooding risks are highly relevant in many European countries. To give an example, in Slovakia both landslides (p. 206) and floods (p. 212) are categorised into three degrees of susceptibility (low, medium, high) and mapped on a national level (see Minár et al. 2009). Indeed living in the proximity to the coast, lakes and rivers involves threats of varying degree, as catastrophes worldwide have shown. While landslide and flood are, of course, different kinds of hazards, they do illustrate the same point: places that are perceived as pleasant or beautiful – or functional – may at the same time be prone to fatal hazards. Here a relevant question of interest is as to how this danger, or the costs of

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mitigating it, affects the value of a residential location for potential property buyers. Further to this, a related question arises: to what extent do we need government regulations to protect people from themselves (Cutter 2008) [1]?

How and the extent to which climate is being altered due to human interventions is one of the issues inherent in the climate change debate. For example, in January 2011, in the state of Queensland, Australia, a normally extremely dry region experienced the worst floods in 50 years, which without any doubt is presented as evidence for the climate change in media (*The Guardian* 2011).This is indeed a global issue – the developing and industrialised countries being in the same boat here (but see Goodwin 2008[2]); whenever the location by a flood-prone river or coast is at stake there is an element of fear. The value balance for water locations is a trade-off between positive perceptions – in traditional jargon *amenity benefits* (see e.g. Earnhart 2001; Boyle & Taylor 2001); in more modern jargon *ecosystem services* (i.e. Nature's services; services maintained by Earth's ecosystems; see e.g. Daly 1997; Norberg 1999) – and negative (flood) risk (see e.g. Morgan 2007). Ostensibly, a water location is, in general, perceived positively by consumers and private developers but assumed negative by planners of housing locations (Goetgeluk et al. 2005; Kauko et al. 2009).

The objective of the study is to investigate the positive and negative effects of proximity to water on the value of residential locations, with possible policy implications, in Trondheim, Norway. Insofar as the homes of inhabitants of Trondheim are situated by the river or coast a rise in water level definitely is bad news: when stabilising minerals are washed away the risk for erosion, and subsequently quick clay land slide, increases. On the other hand, the flooding problem is less relevant in Trondheim than in many other places due to a nationally administered regulation of the river. Nonetheless, the quick clay case illustrates the generic possibilities at hands as well as the inaptness of current regulative frameworks in this context, given that the principles of hazard and amenity effect are to a great extent the same as with the flood case.

In the three sections that follow the problem of water proximity related hazard is discussed from theoretical, methodological and evidence based points of view. The next section comprises a discussion on the conceptual issues introduced above: first, how water is one hand seen as a threat, but on the other perceived as an amenity. Then, in the section that follows a review of previous studies on the topic is presented with respect to background information and empirical evidence on the water nearness related hazards and their regulation. It can be argued that

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[1] According to Andrews (2008) governments should strictly regulate the development of coast locations. He argues that environmental hazards become a social problem too as there is unequal exposure to weather risks across social groups in relation to power. This view is debatable however; see Kauko et al. (2009), for a more flexible proposition.

[2] Goodwin (2008) argues that the only way to tackle the looming climate change and its consequence, ecological and economic crises, is if the rich agree and manage to cut down on consumption and pollution more than the poor do.

people universally both appreciate and fear closeness to water, but that the balance of this always depends on the particular local circumstances: institutional and physical ones. An earlier study on Randstad Holland serves as a background and represents one of the studies reviewed for the literature review (see Goetgeluk et al. 2005; Kauko et al. 2009). A further, more indirect issue concerns how we might justify land use and other kinds of regulative measures to protect inhabitants from harm's way. After that, the Trondheim case is discussed. The concluding section sets an outline for a study on the Trondheim case.

2. The theoretical context

The threat of proximity to water

Flood effects have been part of a recognised research tradition for quite some time, in particular, following the Natural Hazards Research and Applications Information Centre at University of Colorado established by Gilbert F. White (1911-2006) in the early 1970s. Combining his religious beliefs with a lifelong commitment to improving welfare through social policy, White argued that, while floods are 'acts of god', flood losses were largely acts of man (see Kates 2007). Here it needs to be stressed that the wider issue concerning the role of man-made intervention in Nature's proceedings is twofold. On one hand, slide and flood disasters are natural phenomena that have always occurred and will occur in the future too; for example, the 1345 slide and flood disaster in the Gauldalen valley, Mid-Norway, which is assumed to have killed 500, seemed to have happened when a dam, that had been caused by a slide, broke and caused a deluge that affected much of the down-stream valley (Rokoengen et al. 2001). On the other hand, it is argued that human activity changes the environment, which leads to unforeseeable consequences such as increasing the intensities or likelihoods of hazardous events[3], the global climate change being the most dramatic of such effects (Lundberg 2004).

The global climate change – argued to have been caused by greenhouse gas emissions – indeed accentuates the awareness of hazardous effects related to water proximity. While still debated among some economists and other academics

[3] Adam Radzimski (*Adam Mickievicz Unviersity*) have sent me the following information about floods, which occurred in Wroclaw, Poland in July 1997:
'One of the most affected parts was the Kozanów estate. Until 1945, when Wroclaw (Breslau) was a part of Germany, it was called Kosel or Cosel, and was treated as potential flooding area. Therefore, there were only few buildings in the area at that point of time. The situation remained unchanged until 1970s, when the communist government of Poland decided to build a housing estate. It consist of prefabricated, multiple-elevation buildings, which are housing about 25,000 inhabitants. Unfortunately, in 1997 the river Odra burst its banks and covered Kozanów with up to 10 meters of water. On the page http://darkasz.republika.pl/powodz.html you can find some pictures.'

active within his problem area today an inevitable sea level rising due to global warming is accepted as a fact. However, one must also realise that there are serious events, notably *Tsunamis*, which are not related to the climate change[4]. Quick clay landslide is an example of an 'in-between' hazard in this sense: while not being directly caused by the climate change, it is indirectly affected by it as a rise in water level has the tendency to wash away stabilising minerals from the quick clay and thereby increase the risk for erosion and subsequently land slide.

Quick clay landslide is a particular problem that occurs mainly in Northern Europe and North America. This phenomenon originates in the land-rise that has taken place since the last ice age when previously saltwater clay gradually ceased to be submerged. Today such clay constitutes large parts of the soil coverage in the coastal zone. It has a structure of a card house where minerals give rise to electrochemical forces that keep the structure together. When these necessary minerals are washed away these ties also loose their function. What makes this hazard so special and feared is that quick-clay has the tendency to lose its solidity and turns into liquid when being subject to shaking. Initially such clay can be as solid as ordinary clay, and bear hard movements such as building or road works without any such landslide occurring as long as it is handled with care. However, when the groundwater level rises, these binding forces between the particles are reduced. Therefore, heavy rainfall and flooding strengthen the forces of erosion, and this in turn can cause increased likelihood of such landslides along rivers and streams (Janbu et al. 1993; Sveian et al. 2002).

The enjoyment of living near water as a balancing factor

Apart from the assumed negative effect, water also has obvious positive impacts on house buyer behaviour. Individuals who contemplate a house purchase tend to prefer beautiful surroundings and often there is an element of view or proximity with regard to river or coast. Perhaps such a location offers prospects for hobby activities such as boating, waterskiing and fishing. In some cases consumers are willing to pay a high premium for such locations. In recent years a wealth of studies has been published on how the water environment – or one particular aspect therein – in one way or another might generate a price premium (e.g. Earnhart 2001; Boyle & Taylor 2001). As such we need to consider a net effect, the extent of which is multidimensional and, arguably, most of the time also context specific (Goetgeluk et al. 2005).

Dalrymple's (2006) literature review lend support to the basic argument of proximity to water having a real (but complex) impact on residential property

[4] Although fantasy-novelists are of course entitled to counterfactual speculation. Here Isomäki's (2009) doom-and-gloom scenario is worth noting: he claims that the meltdowns of the polar glaciers, plausibly, leads to their movements on water-streams, and when these gigantic blocks of ice eventually slide into the oceans, subsequent mega tsunamis occur.

values and moving behaviour – sometimes positive and sometimes negative. She reviews a several relevant issues related to water (recreation, resources and ecology), and evaluates a variety of methodologies applied in the literature. After mainly reviewing Anglo-American and, to a lesser extent, European sources, she makes a number of conclusions around the theme of how the water environment is perceived or valued by the public. As for her conclusions, for the purposes of the present paper suffice is to note that people do engage with the water environment both positively and negatively; that the views and values vary significantly across groups in terms of socio-economic and demographic differences, geographical and cultural variables, and one's prior knowledge of an environment; and that different results may be attributed to different methodological approaches adopted (cf. Goetgeluk et al., 2005).

3. Findings from previous studies

The literature review (carried out in a prior study)

The literature review of Kauko et al. (2009) covered about sixty studies, most of which were *hedonic house price analyses*. This is a rather common method within neoclassical microeconomics, with several applications in a range of problem areas, notably index construction, property valuation, and environmental impact assessment. Explained briefly, according to its underpinnings the total price of the dwelling is assumed to be comprised of partial prices of its characteristics, i.e. 'shadow prices'. These are attribute-specific coefficients, determined by multiple regression analysis techniques and large datasets where transaction price together with other relevant characteristics are recorded for each observation. Subsequently these estimates can be applied for cost-benefit analysis, among others, for estimating the impact of an environmental measure (see e.g. Michaels & Smith 1990; Des Rosiers 2002).

Contingent valuation was another commonly applied method in this literature. On top of these studies also a few judgmental and *multi-dimensional preference/choice modelling* studies were reviewed. The main difference of this mathematical but context sensitive approach to the hedonic approach is that no market equilibrium is assumed, that no statistical sampling takes place, and that the data is collected interactively with transformations from initial ordinal to eventually cardinal measures (see e.g. Saaty 1990; Ball & Srinivasan 1994). On balance, the results pointed to an amenity effect of about +10% for coast location. This attractiveness premium for property value applies for the sea coast, but to a lesser extent to situations by (or in close proximity to) rivers, canals or lakes (See Kauko et al. 2009).

According to other recent empirical studies coastal amenities and risk are continuing to be highly correlated, and that separating these factors by using sophisticated methodology that builds on the hedonic framework together with GIS therefore is potentially challenging (Bin et al., 2008b). The nature and extent of such phenomena are however empirical questions.

Bin and colleagues (2008a) found that situation by a flood zone increases home value substantially (up to 27%). Elsewhere, McKenzie & Levendis (2010) showed that in New Orleans premiums for building costs in flood-prone areas increased from 1.4% before Katrina to 4.6% after Katrina. Thus, in some circumstances the amenity value element view, whereas in others it is the abatement costs of flooding that are more relevant.

The case of Randstad Holland (analysed in the prior study)

The Randstad Holland context is characterized by the following circumstances:

- it is one of the densest regions in the world, most of which is situated below sea-level.
- The presence of proactive public sector actions: here is strict spatial regulation of development in locations close to the coast, waterways or smaller bodies of water, even if the flood risk is small.
- A contrasting view of property developers: thanks to the environmental amenity value of water locations, mixing water locations and housing locations may bring profits, which subsequently can be spent for social goals too, which implies that the government should relax the planning regulations.
- An innovative option for marketing and design: *floating homes*.

The following categories of respondents participated in the study (seventeen of them in total, interviewed face-to-face, on-site, during year 2003):

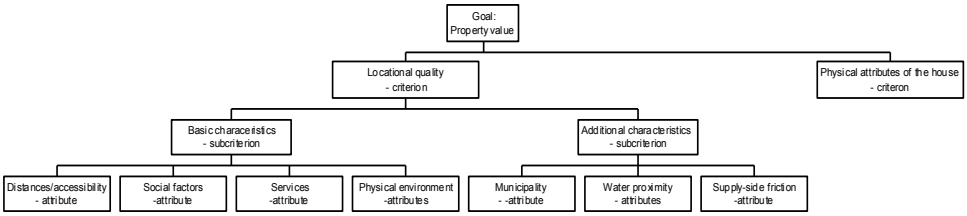
- Managers of development/building companies in the owner occupied sector.
- Real estate agents and assessors.
- Managers of housing corporations.
- Representatives of consumer stakeholder organisations.
- Government planners and other experts.

Due to general problems related to the use of 'reductionist' methods (i.e. methods that compress the dimensions under study to one a single monetary measure) such as hedonic modelling and contingency valuation, an innovative multi-attribute or multi-criteria decision modelling technique known as *the analytical hierarchy process (AHP)* was applied on expert judgments, with additional in-depth interviews of the same experts adding a more qualitative element to the triangulation (see e.g. Goetgeluk et al. 2005; Kauko 2005, 2006).

The 'value tree' model applied for the AHP is shown in Fig 1. This illustration shows how the attributes in question relate to the overall goal, property value. In this scheme the water element is represented as one of the seven attributes that – based on practical experience and economic theory – are assumed to increase or decrease the property value (or similarly affect the moving propensity in housing choice studies usually carried out by quantitative geographers). This scheme is used for eliciting the percentage weights for each pre-specified attribute from the responses. This occurred through a pair-wise comparison of each element, with

respect to the higher level of elements, and begins bottom up from the 'leafs' towards the 'goal'. (See Kauko 2005, 2006). Using this method a figure was computed for the net effect between amenity benefit and risk related costs.

Figure 1. The applied research design in terms of model structure and selected variables.



This study arrived at results of a similar magnitude as the literature review: that is an average positive effect of ten percent. As for the in-depth interviewing part, the positive effect perceived exceeded the negative one. 'We are not afraid of flooding' – as one respondent so boldly put it, when referring to the inhabitants of an area that in the 1950s experienced some of the worst floods in the history of the Netherlands! However, in this context a number of caveats need to be taken into account:

- The findings depend on the geographical and institutional circumstances.
- The net effect can be negative in those cases where the abatement costs exceed the amenity benefits.
- Although the literature and the AHP based fieldwork documented above arrived at the same result in this particular case, one cannot generalise beyond the empirical context covered.

The literature suggests, by and large, that the consumer preferences for water locations bring an attractiveness premium of approximately ten percent for the coast but less so for river, canal or lake. The prior study based on expert judgements and AHP does also indicate a ten percent weight for water related attractiveness. However, the effect is negative in certain cases (the inner city and urban extension areas, in particular), where costs exceed benefits. Furthermore, validity is an elusive issue to overcome. (These findings much resonate with those by Dalrymple discussed above).

Regulative measures to cope with hazards

The interesting issue here concerns the direction of the perceptions – of housing consumers on one hand and the government regulators on the other. Because of the threat factor, in an environmental hazard prone coastal location housing

consumption is affected negatively, for sure, but also production (i.e. planning and development) of residential areas is affected indirectly at least. In other words, an argument against the provision of new housing in a hazard prone zone is created. However, Goetgeluk et al. (2005) and Kauko et al. (2009) argued that where the proximity to water generates a premium in property values in the Randstad Holland region – inner city areas and inner suburbs in particular – its role should not be overlooked when assessing possibilities for financing water retention schemes.

Another example that shows the possibilities of utilising the premium for waterfront locations, much in same vein, albeit with conclusions completely opposite to the promising search for innovations in the Randstad mentioned above, is the situation with regard to flood abatements of River Danube in Budapest. Unsurprisingly, waterfront or shore location (with a view of the river) commands a huge premium everywhere along the river – in particular, in the city centre the price increase might be 100% compared to a similar condominium in the same block but without such a view.[5] However, in the Buda-side neighbourhood of Római fürdo, the problem compared to the rest of the riverfront is that no flood barriers exist. As a consequence, this part of the river is always flooded. Many residents in this neighbourhood are of the opinion that to finance a flood barrier is not the responsibility of the local government (in this case district III; one of the 23 local governments that comprise Budapest), and that instead it is the home purchasers who ought to pay as these households are often upper market groups and also would be able to afford such an extra cost on top of the house price. This is however an impasse situation: newspapers write about it and the inhabitants complain but as long as private developers or house-builders do not agree with the local government about the share of responsibilities and the issue remains a perennial one. Until the issue is resolved a moratoria which restricts new housing development to holiday homes[6] is on (Personal communication).

Morgan (2007) obtains some evidence on the impact on the proximity to coast and flooding on property values in relation to the Hurricane 'Ivan', in a coastal zone of Florida. Theoretically, the quality adjusted price difference between properties in flood-prone areas and those in not flood-prone areas should equal the risk related price difference between such locations. The findings however suggest that, even after 'Ivan', the aesthetic benefits of view exceed the risks associated with flooding. The price premium of such locations is 27%, which after 'Ivan' falls with 15%. From this it is then concluded that the current insurances are too cheap in relation to the risk. Bin et al. (2008b), however, offer conflicting evidence. They use he-

[5] For example, *Duna-Pest* 'residential park' type of new developments (in effect a gated community of high rise blocks) have a price tag of 700,000 HUF/sqm (3,640 USD/sqm) if facing the river and only 350,000 HUF/Sqm (1,820 USD/sqm) if facing Boráros Square; in the fifth district Belgrad rakpart second-hand condos with river views sell for 1,000,000 HUF/sqm (5,200 USD/sqm). To compare, an average price for second-hand condos in downtown Pest districts varies between 200-550,000 HUF/sqm (1,040-2,860 USD/sqm).

[6] For such buildings no mortgage is allowed.

donic analysis of more than 3,000 property sales in Carteret County, North Carolina, USA, to examine the effects of flood hazard on coastal property value and conclude that, while location within a flood zone lowers property value by an average of 7.3 percent, and the discounts are larger for higher risks, the capitalised values of the insurance premiums are in close agreement with the sales price differentials.

Thus some of the evidence from the US indicates that price for a home in non flood areas approximately equals the price of a flood prone location plus the capitalised value of flood insurance. This would put fait in the market forces as allocator of such risky sites: you can move there but it is on your own responsibility and conditional upon paying high insurance premiums. It should however be accentuated that the issue investigated by Morgan and Bin et al. above is particular for the US regime of insurances and adaption to these by individuals. In other countries other issues are more relevant. It also needs to be understood that, in reality, governments do not recommend building in environmental hazard prone locations, because the costs of evacuation can be substantial indeed. Notably, in 2005 Hurricane damage in the US amounted up to 105,790 million USD; the Hurricane 'Katrina' alone caused damage for more than 80,000 million USD (Sah et al. 2008).

In sum, there instead of one-size-fits-all thinking, more governance and decision-making at the local and regional levels, as well as cooperation among municipalities is vital in coordinating various regulation and development functions. Moreover, in these times of public sector financial shortage any attempt to initiate private developers to the framework of hazard abatement seems a worthy endeavour. However, in doing so the particular institutional context is deterministic and must therefore be paid close attention to in the research design.

4. Widening the empirical context

Environmental hazard circumstances in Trondheim

The discussion so far has singled out a number of economically, socially, and spatially important questions: Do the consumers have preferences for water locations? Is the added value of water location positive or negative? Should the consumers be allowed to choose their residential location freely, even if a certain risk is involved? Or to put the last, normative question more positively: is it really wise to have tight regulations for land use that leave little room for innovative financial mechanisms? As already the previous section indicated, these issues are largely empirical ones and, while omnipresent to a certain extent, they give different outcomes in different contexts.

This paper focuses on Trondheim, Norway. Trondheim is the third largest city in the country and regional capital of about 160,000 inhabitants, situated by the coast in mid-Norway. In Trondheim the terrain tells about several tens of quick clay landslides in that have occurred. The biggest ones documented occurred in year 1625 killing twenty people; and in 1634 killing at least three people. While the last major landslide occurred 1943, smaller ones occur on average every ten

years (Janbu et al. 1993; Sveian et al. 2002). In this context the interesting question is: what are the relevant normative institutions and regulative processes in these circumstances?

According to forecasts, climate changes are likely to induce more rainfall and landslides in various parts of Norway. The project *GeoExtreme* was established in 2005 with one of its aims to investigate whether the risk for landslides will increase in the future. As for today, only some intuitive rules exist for various hazardous elements and threshold values. Currently 48,000 properties (2.8% of the total number) in the country are exposed for avalanche or skipping rocks. If the zone of hazard is widened by only 10 meters the corresponding increase in this figure would be around 25%. This would justify the request for tightening the current regulations for land use. The planning and building law of 1986, which also provides the basis for detailed hazard zone maps, establishes that houses cannot be built in areas where landslide can occur more frequently than once in 1,000 years. In fact, the behaviour of humans themselves is an important trigger for such events in both historical and contemporary times; thus the problems are not primarily only due to climate changes but due to our area use. (Jaedicke 2009)

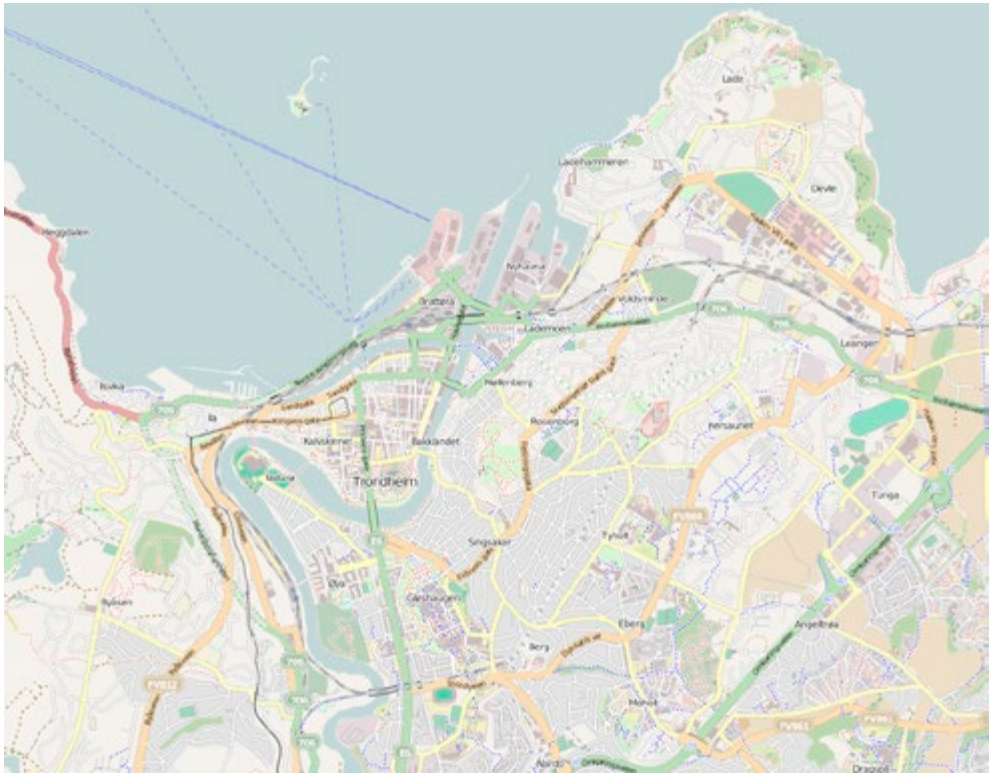
What then is the corresponding situation in Norway? Here the particular legal and administrative structures are crucial to understand the issues at stake. It is evident that the experiences from other countries such as Netherlands (the AHP exercise discussed above) or USA (where most of the cited literature comes from) cannot be used directly as methodological framework for evaluation of floods – and certainly not evaluation of quick clay landslide – in mid-Norway, because the perception and adaption to floods must take into account the legal and administrative structures in the country. This is because the institutional circumstances are different; namely, laws and regulations for building, zoning in relation to quick-clay and floods and governance concerning how one manages to raise money for building hazards mitigation schemes using public-private-partnerships (PPP) or otherwise.

Particular features of the quick clay areas in Trondheim

The results of the literature survey referred to above indicate how both price premiums and discounts are associated with waterside locations. In Trondheim landslide might pose similar questions about the relationship between amenity benefits and risk related costs. The most well-known such examples are the following two areas in the inner city (see fig. 2):

- The riverfront 'Nidelven Terasse' seems exposed to floods (although is not really, due to national protection regulations), yet very expensive housing locations – even Nedre Elvehavn, a recycled waterfront site further down the river, another expensive location, and seems exposed to storm. Both locations are situated in the city core.
- High risk for quick clay in areas that traditionally have very high prices – including particular high status areas such as 'Øvre Singsaker' (situated on a hill in the eastern part of the inner city).

Figure 2. Map of Trondheim.



As fig. 2 shows, River Nida flows through Trondheim. Due to a national policy Nida is however strongly regulated by barriers and tunnels, with a substantially reduced risk for floods. Apparently flooding then can be considered less a threat than quick clay landslide in Trondheim, but the basic problem is much the same. For quick clay areas situated by the river or coast a rise in water level definitely is bad news: when stabilising minerals are washed away the risk for erosion, and subsequently land slide, increases. The risk for quick clay land slide is high in areas that traditionally have very high prices – including particular high status areas such as the abovementioned case of Øvre Singsaker neighbourhood. One finding may therefore be that risk level, price level, and social standing are spatially associated.

Let us now speculate about the possibilities to build within the landslide risk or flood-zone areas in Trondheim (the discussion below is based on personal communication). The areas where building is not allowed without documentation of the stability of the area are indicated in map that comprises the 'area' section of the Master plan of the municipality (*Kommuneplanens arealdel*, *plankarten* 2007-18). This is referred to as the 'River Nida Corridor'. Outside settelments the zone is 100m. The reality here is twofold:

1. The rules are not completely exclusive towards building, even if they get stricter all the time. It can also be argued that obtaining building permits becomes easier with denser plots.
2. Thoughts about jointly financed new development actions exist already:
   a) the private actors who are going to build will pay. This will be tested at the market. But do people wish to pay for this as extra price element? Perhaps, if it can be perceived as merely a cost-post among lots of other cost-posts.
   b) The municipality merely coordinates these actions:
      – If the municipality themselves are included as partners in a building project, they participate together with other instances in such costs.
      – At a more general level, the municipality assesses and secures the river and streams against erosions in such a way that landslides will not occur.

The findings indicate that in the Norwegian/Trondheim context the problem is that regulations are too tight as the government has an old fashioned role mainly as regulator. As with so many other kinds of regulation in the society, the present building and protection regulations are based on the outmoded ideology of 'protecting consumers from themselves'. The opportunities opened by governance conceptualization are not utilized fully. It is acknowledged that the private sector can handle many things better than the government, and to go back to the main argument: by using the premium for selling the properties it is possible to finance protection measures.

Thus, compared to the mentioned case, is the Trondheim situation closer to the innovative solutions of Randstad Holland, or the disagreement of Budapest district III? At the outset the issue concerning quick clay, flooding and sea-level rise in Norway is a status quo due to rigid restrictions stipulated by the law. Currently (since the floods of 1995) the building close to rivers and coasts is regulated by law and municipality does not have much room to act. (For instance, one is not allowed to build within a certain buffer zone from the river.) Another issue concerns compensations due to damage caused by flooding or landslide.

Arguably, the regulations in relation to flood and landslide mitigation are too rigid in this country. Is there a possibility towards a less paternalistic welfare state planning system where the guiding principle would be cooperation rather than forbidding. The Trondheim case shows serious short-comings in the regulation of floods and quick-clay landslides. For the former hazard, the local government can be considered particularly rigid. For the latter in turn, some flexibility exists, but the builder has to pay for site surveys, and still may not be able to convince the planning officers about the feasibility of the project. We note here a variant of the argument about planning lacking a housing market perspective often heard in the UK, in other words, land use regulations that do not give enough permissions for building lead to a constrained housing supply and subsequently to escalating house prices and unaffordable housing for modal income takers (Jones, 2010; Bramley, 2007; Barker, 2003, 2004). The same or related issues have also been subject to fierce debate in other countries, notably in the Netherlands (see Priemus & Rietveldt, 2009).

Data sources and methods

What are the opportunities for financing environmental risk abatement or water retention mechanisms from housing developments those who are willing to pay the premium in Trondheim? The issue concerns the Norwegian regulations of riverbank building in general and within quick clay zones, in particular. The data to be utilised for studying this empirically should include secondary databases of house price data, as it can be argued that the property transaction contains useful information (i.e. the justification for hedonic analysis). The minimum coverage of the data on Trondheim therefore needs to be the settled share of the urban area that overlaps with the coast of the Fjord of Trondheim and the shoreline of river Nida (see fig. 2). In this case, such data comprises the following elements:

- an indication of the zones affected by quick clay and flooding, respectively. *Norge Digitalt* contains some information of the danger zones for quick clay landslide.
- Aggregate statistics on socio-economic indicators – this is due to the argument of Cutter (2008) about varying vulnerability of different strata.
- House sales prices as a measure of attractiveness. Property sales price data can be picked from an on-line system *Norge Digitalt* where several kinds of databases are made available, most of them free of charge.

Here the address of the home is linked to the ward and district via GIS polygons, or via the housing info of the databases mentioned above. However, compatibility problems require lots of attention. In this case the issue is about building a dataset where individual data on price, building, building, plots correspond with each other, and can be further combined with aggregated data on various relevant demographic, socioeconomic and hazard data accessible from the statistical office of Norway (*Statistisk sentralbyrå – SSB).*

According to d'Amato & Kauko (2008, p. 285):

> *'In some case the information may be available but not always reliable, which means that market data do not reflect the market reality well. In some other cases the information is not well organized, which implies a poor data management and infrastructure (i.e. the way data is accumulated and distributed) within the organisation in question.'*

Using the technique *polygon overlay* at least one ordinal variable for the risk for quick clay landslide was constructed and combined with the house price data using the areal unit as key. However, during the course of this exploration it turned out that in the acquired dataset of single family homes sold in Trondheim between 1993 and 2008 none of them was situated within a potential flooding zone, even when the 500 year flood was used as a criterion. Therefore, the quantitative part in preparation is limited to the quick-clay landslide case only.

The positive discovery here is that transactions data of dwellings was easily available in large quantities. On the downside, however, it was to note that due to the legal aspects of information protection it was not possible to obtain all kinds of

socio-economic or even demographic data at an intra-municipal district level, but only at a coarser level of 'part of municipality'.

The set up for the case-study is based on prior studies. Local data will be analysed using state-of-the-art empirical modelling approaches, notably classification based on pattern recognition. Using sophisticated classification techniques, such as the self-organising map (SOM), data on the long-term development of prices, the environment and socio-economic indicators are related to each other (see Kauko 2005). In a classification the goals are as follows:

- measurement of attractiveness;
- comparison of different locations and household profiles;
- to ascertain context effects, in particular, where and for what kind of households the effect is positive, negative or non existing.

5. Summary and concluding discussions

Apart from the assumed negative effect associated with flooding, landslide and other hazards, water also has obvious positive impacts on house buyer behaviour. These impacts may furthermore generate profits in housing construction projects, which is beneficial for the community if public expenditures could be financed partly based on these profits. The nature and extent of such phenomena are however empirical questions and pertain to consumer preferences for water locations and whether the added value of water location is positive or negative.

Prior research by the author suggests that abatement mechanisms might be financed based on the added value of the new developments in the location. This kind of innovative financial mechanism however requires close cooperation between private developers and local authorities – in other words, governance instead of government – as well as flexible legal codes. Needless to say: to retain the financial viability, such developments also need to be attractive for the upper housing market target groups. Often policymakers (and those writing research papers for them) fail to understand the problem of constraining land use planning from a housing market point of view. This is something that has been debated in other countries: when the housing affordability goal is neglected, modal income takers cannot afford to live there. The Norwegian system has much similar problems (see also Kauko, 2010).

Lastly, the balance between positive and negative effects ought to be looked at in relation to the geographical-institutional context. The findings from the Norwegian case study add an interesting aspect to the framework: municipality still has a negative, regulating attitude to new building by private actors, even if some cooperation occurs. Apparently the innovative measures that have been considered in a number of other countries are not possible in Trondheim. However, if demand for attractive scenery exists – although not only over the sea or water ways, but the view as a whole – the builders might be able to pay for the necessary safety measures in relation to quick clay landslides. If such safety measures can be provided using the profits for housing developments by the water, as can

be argued based on the Dutch experience related to flooding, why not apply similar financing strategy based on price premiums for landslide abatement infrastructure too? This model may in fact be extended to all kinds of hazards and risks.

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