# Dependence, trust, and influence of external actors on municipal urban flood risk mitigation: The case of Lomma Municipality, Sweden

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ABSTRACT

Floods constitute a major problem that cross geopolitical, administrative, and sectoral boundaries, and must as such be jointly governed by a web of actors. The patterns of social relations among these actors are fundamental for society's capacity to mitigate flood risk. The purpose of this study is to contribute to our understanding of flood risk governance by investigating the social organization of formal actors that contribute to mitigating urban flood risk in Swedish municipalities. It applies Social Network Analysis to examine what patterns of dependence, trust, and influence of external actors emerge in the accounts of politicians and civil servants in Lomma Municipality, Sweden. The results indicate interesting patterns in type of input, as well as the role of personal relationships and different forms of authority for trust and influence. There is also a horizontal de-coupling between municipalities along the river, as well as a vertical decoupling between the municipal and the national level, where withdrawing national authorities leave a void increasingly filled by private companies. These patterns of social relationships between municipal and external actors contributing to mitigate urban flood risk are important for understanding flood risk governance in society.

## 1. Introduction

Floods constitute a major global problem and are the most common recorded disasters around the world [1], increasing particularly in urban areas [2]. Flood risk is of great concern in Europe and threatens to undermine the sustainable development goals of the European Union [3], especially since it is expected to escalate with climate change and the other processes of change continuously redrawing the risk landscape [4]. Floods tend not to be bounded by geopolitical or administrative borders and involve various sectors of society. It is therefore not possible for one individual or organizational actor to analyse, evaluate and manage flood risk in society alone. It must instead be jointly governed by a web of actors [5] who are not independent of each other, but dependent on various resources and affected by the decisions and actions of others [4]. The patterns of social relations among these actors are therefore fundamental for society's capacity to reduce risk [6]. While the importance of social relations for risk governance has been investigated from many angles [7–11], this social organization of resources and influence has not been studied in relation to the mitigation of urban flood risk and is likely to vary with the differing models of governance across Europe. These models are relatively similar among the Nordic countries,[1] with both responsibilities and resources largely decentralized to the municipal level [12].

Swedish municipalities are relatively large and complex organizations with a broad range of responsibilities. Although all have the mandate of mitigating urban flood risk within their jurisdiction, it is interesting and important to investigate what external actors contribute and how the municipalities depend on them. Being dependent on some input from another actor introduces the importance of trust as an expectation that is based on incomplete knowledge about the likelihood of receiving the needed input, as well as incomplete control over that happening [13]. Moreover, dependence connotes a power relationship [cf. 14], and it is interesting and important to also investigate the influence external actors have on the municipalities' ability to mitigate urban flood risk.

The purpose of this study is therefore to contribute to our understanding of flood risk governance by investigating the social organization of formal actors that contribute to mitigating urban flood risk in Swedish municipalities. In an effort to reach that goal, this paper intends to answer the following research question:

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[1] Here limited to Sweden, Denmark, Finland, Norway, and Iceland, but also acknowledging the autonomous constituent country of Greenland and Faroe Islands belonging to Denmark, as well as Åland belonging to Finland.

*What patterns of dependence, trust, and influence of external actors emerge in the accounts of municipal politicians and civil servants who contribute to urban flood risk mitigation in a Swedish municipality?*

## 2. Theoretical framework

This section of the paper aims to do two things. It attempts to provide brief conceptual clarifications of a number of concepts that make up the core of the research question, and it introduces the theoretical perspective used in this study.

First of all, the context of this study is urban flood risk mitigation, which involves four central concepts: *urban*, *flood*, *risk*, and *mitigation*. Although there is no universally accepted definition of what is meant by *urban* [15], it is usually considered as a range on a rural–urban continuum that includes (sometimes villages) towns, cities, metropolitan areas and megacities. This study focuses on the mitigation of flood risk that affects the town of Lomma, clearly falling within this *urban* range, and does not consider flood risk affecting the countryside around the town. The next central concept that requires clarification is *flood*, and then mainly to provide background to the selection of the case of Lomma described in the methodology section. *Flood* can be simply defined as 'the temporary covering by water of land not normally covered by water' [16]. The processes behind floods are, however, complex [17] and it is important to note that they are vital for wetlands, biodiversity, certain farming practices, etc., making flood risk governance particularly challenging [4]. There are at least five main types of floods (Table 1), but any one particular flood event may be a combination of several types [4].

*Risk* is a contested concept with various definitions [18], and there is no room to elaborate on it here. *Risk* is thus simply defined as uncertainty about what could happen and what the consequences would be [18], focusing only on negative consequences [5]. When contemplating what could happen, how likely that is to happen, and what the consequences would be, if that happens, you are analysing risk [19]. However, answering these questions in relation to floods requires consideration of location, magnitude and spatial extent, speed of onset and duration, as well as likelihood of various potential flood events [4]. It also requires explicitly considering what is valuable and important to protect in the areas potentially flooded and how susceptible that is to be negatively affected by the impact of the water [4]. It is important to note that estimations of any of these factors are fraught with uncertainty [18]. Finally, *mitigation* is here broadly defined as comprising all proactive activities that reduce the likelihood of flood events and/or their consequences before occurring [20], but leaving out preparedness for effective response and recovery.

Secondly, Ingold and colleagues [6] argue the critical importance of the structural patterns of social relations to understand collective capacity to reduce risk. The theoretical perspective used in this study assumes that it is these patterns of social relations that together constitute social organization [21]. Social organization can, in other words, be elicited from direct empirical observation of the social interactions

that constitute these social relations. It is thus important not to conflate social organization and social structure [22], which captures the importance of social institutions, norms, and behavioural expectations [23,24] that are generally considered persistent, continuous, pervasive, and maintained through repetition [25]. However, social organization is not random or implying accidental patterns, but orients to socially defined goals. Even under the forces of social structure, the ordering of action and of relations in reference to given social ends still allow room for individual choice [22]. Social organization is thus both a social process and an outcome in terms of the arrangement of social action towards particular goals – the mitigation of urban flood risk in this case. Such goal must have some element of common significance for the actors involved, although it need not be identical, or even similar, and might be opposite for some of them [21].

This relational focus makes social network analysis a suitable theoretical perspective [26] that has been applied to a range of research problems in risk governance [6,10,27–29]. Structural analysis has long been suggested a useful approach when attempting to grasp complex social reality [30,31], but has through coevolution of thinking and technology come to encompass an immense variety of theories, techniques, and tools [32,33]. Hence, only parts are applicable to investigate the patterns of dependence, trust, and influence of external actors among municipal politicians and civil servants contributing to urban flood risk mitigation, which are elaborated on in the methodology section below.

Finally, the aspects of social relations investigated in this study entail three additional central concepts: *dependence*, *trust*, and *influence*. Many scholars point out *dependence* between actors as crucial for organizations' capacity in general [34], and for understanding risk and their capacity to mitigate risk in particular [e.g. 4,5]. It is therefore important to study dependencies of required inputs between actors. There are numerous types of input that actors contributing to urban flood risk mitigation might require to be able to perform their specific tasks, and there are many ways to categorise them. To be able to study this at all, seven types of input were elicited from literature. These include reports of activities [35], equipment and material [36], funding [37], technical information [38], rules and policy [38], advice and technical support [34], and pepping and moral support [36]. Although not including every possible input, these types of input are deemed to cover sufficient width to investigate *dependence* between actors in this context.

Being dependent on some input from another actor introduces the importance of *trust* as a basis for reducing complexity in terms of the range of action or non-action by that actor to consider [39]. It is thus of utmost importance for the cooperation [40] that is necessary for risk governance [5]. *Trust* is an incredibly complex concept with many definitions and uses across several disciplines [41]. However, it is here applied as an expectation that is based on incomplete knowledge about the likelihood of receiving the needed input, as well as incomplete control over that happening [13]. *Trust* is, in this study, therefore about the level of confidence actors have that they will get the input needed to perform their tasks from each other actor they are dependent on.

*Dependence* and *trust* are both related to *influence* [39,40], which denotes the capacity of one actor to have an effect on the performance of another [cf. 42]. It is obvious that being dependent on a particular input from another actor confers influence to that actor over you, but *influence* entails more than such *dependence* [cf. 39]. It entails authority, regardless if based on legal, traditional, or charismatic grounds [43], or on the competent authority of expertise [44]. It is also related to friendship [45]. *Influence* is thus in itself a fundamental part of the social relations between actors contributing to mitigating urban flood risk in the municipality. Let us now empirically investigate the patterns of *dependence*, *trust*, and *influence* of external actors as they emerge in the accounts of municipal politicians and civil servants who contribute to *urban flood risk mitigation* in Lomma Municipality, Sweden.

**Table 1**
Types of floods.

| Type of flood | Description |
| --- | --- |
| Pluvial flood | caused by insufficient drainage from local topographical lows |
| Fluvial floods | caused by too much water in a watercourse |
| Coastal floods | caused by storm surge or sea level rise |
| Groundwater flood | caused by rising groundwater |
| Breaching flood | caused by water breaching natural or man-made retention barriers |

## 3. Methodology

A single-case study research design with multiple embedded units of analysis was used to address the research question [46]. Although relative similarity is likely between flood-prone Swedish towns, it is most appropriate to select an extreme case 'because they activate more actors and more basic mechanisms in the situation studied' [47]. However, considering a flood-prone Swedish town as an extreme case not only has to do with experiencing extreme flood risk. Significant flood risk is necessary, but not sufficient for selection. It also has to do with the complexity of the flood problem that the formal actors have to address. In other words, a town that is exposed to as many types of floods as possible – as described in the theoretical framework – and that is currently experiencing significant changes in terms of population growth and urbanization, exploitation of new areas, and densification of existing areas.

Lomma is a town in southern Sweden that is experiencing extraordinary changes. It is rapidly extending into new areas along both the coast and the river Höje Å, and is undergoing significant densification in terms of buildings and infrastructure in its centre. Large parts of Lomma are exposed to either coastal floods, or fluvial floods from the river, or both, due to the proximity to the sea and river, and a very flat topography. The topography and geology of Lomma also combine with intense and increasing rainfall to generate significant exposure to pluvial floods across much of the town, potentially aggravated by groundwater floods. The risk of all these types of floods are expected to increase with climate change. Moreover, these types of floods may occur simultaneously, which is anticipated to happen more often in the future, also due to climate change. This further escalates the complexity of the flood problem. Hence, Lomma provides a suitable case for the purpose of this study.

The relational focus of the study makes social network analysis a suitable methodology for studying the case [26,48]. Social network analysis is particularly appealing when not only interested in the relations among actors, but also in their patterns and implications [26]. Considering the focus on investigating the social organization of contributing formal actors, a whole network approach to social network analysis is required [48]. This means that 'all' contributing formal actors must be included. Formal actors are here defined as individuals contributing to mitigating flood risk in Lomma Municipality as part of their professional activities or as significant property owners in the catchment area of the river running through Lomma town. Answering the research question requires a distinction between internal and external actors, where the former comprises all identified actors working for Lomma Municipality and the latter everybody else (Table 2). This social network analysis focuses thus on network and group levels (e.g. density, density ratio) and on associations between ties (i.e. QAP correlation, QAP Regression), and not on node level (e.g. degree, betweenness, eigenvector centrality).

Since I did not know from the start the boundary of the social network under study in terms of who would be formal actors in this context and who would not, the respondents were selected by means of a snowballing technique [26,48]. The snowballing started with 10 respondents at Lomma Municipality who were identified as likely to contribute to the mitigation of flood risk, such as the water and sanitation manager, planners, the building and environmental manager, technical manager, risk and security manager, etc. The snowball sampling technique involved using a name-generating question concerning who each respondent depends upon for input to be able to contribute to mitigating flood risk. The snowball sampling continues in principle until no more new respondents are identified, but involves in practice boundary judgements of relevance. This means that for an identified individual to be selected as a respondent, a judgement was made about the likelihood of the person having relevant information about the mitigation of flood risk in the selected case. This judgement was kept as open as possible, but was restricted to the inclusion of (1) friends and family members who give general advice, but were not relevant to interview concerning the case; (2) staff and subcontractors who perform specific practical tasks without considering their effects on flood risk mitigation; (3) administrative managers who are only responsible for salaries and admin; and of (4) organizations, software, legislation, and guidelines that are identified, but not possible to interview. This resulted in 35 respondents within the Lomma Municipality, together identifying 105 formal actors (including themselves) who contribute to their work to mitigate urban flood risk in the municipality.

Data were collected through structured interviews using a questionnaire with structured questions about different attributes (organization, gender, age, work experience, and education) and ties to the other formal actors. The *dependence* between actors is operationalized as the importance of the seven different types of input identified above (reports of activities; equipment and material; funding; technical information; rules and policy; advice and technical support; pepping and moral support), rated on a five-point Likert scale from not at all (0) to extremely important (4). The respondents were also asked to rate the level of *trust* they have that they will be provided with the input they need from each identified other actor (on a similar Likert scale from no *trust* to full *trust*) to rate the level of *influence* these actors have over the respondents' ability to contribute to mitigate flood risk in Lomma (on a five-level scale from no *influence* to extremely big *influence*), and to describe the relationship they have (on a five-point scale with 'do not know', 'associate name with face', 'acquaintance', 'know well', and 'personal friend' [cf. 49].

Each interview took between 60 and 90 min, with a few shorter interviews with actors less engaged in flood risk mitigation. All interviews were done face-to-face regardless of the high demand for time and resources, since whole network approaches are sensitive to missing data and personal contact minimizes non-responses [48]. Face-to-face interviews also allow for clarification of questions and facilitate elicitation techniques and probing to improve respondent recall [48]. The social network data collected were then analysed on dyad, node, and network level with the assistance of the software UCINET [50], and with SPSS to compare average strengths of actual ties (Independent sample *t*-test, assuming independence in respondents' answers).

**Table 2**
Distribution of formal actors between categories of organizations.

| Actors in the network | # | Note |
|---|---|---|
| **Lomma Municipality** | 35 + 16 = 51 | 35 respondents plus 4 that have left the organization, 3 administrative managers not considering themselves as contributing, 8 technical staff performing practical tasks (only interviewing their team leaders), and 1 municipal call centre |
| **Other municipal organizations** | 5 | Höje Å Water Council, the Fire and Rescue Services, the Erosion Damage Centre, a neighbouring municipality outside the catchment area, and a municipality in another part of Sweden |
| **County Administrative Board** | 6 | 6 civil servants |
| **National authorities** | 13 | 4 named individuals and 9 identified with the name of the organizations |
| **Private companies** | 23 | Mainly consultancy firms and contractors, but also insurance companies in relation to past flood damages of households that are used as input for urban flood risk mitigation. |
| **Universities** | 2 | 2 nearby universities |
| **Private citizens** | 2 | Citizens and landowners |
| **No organization type** | 3 | A legislation, former court rulings, and a reference group |

## 4. Results

In an effort to analyse patterns of *dependence*, *trust* and *influence* between external and internal actors contributing to mitigating urban flood risk in Lomma Municipality, I analysed the entire network of formal actors (105 formal actors) focusing on the various ties between different external actors and the individuals actively engaged within Lomma Municipality (35 respondents). I also analysed ties within Lomma Municipality for comparison. The nodes of the network are distributed between Lomma Municipality, other municipal organizations, the County Administrative Board, national authorities, private companies, universities, private citizens, and a few without organization types (Table 2). It is interesting to note that nobody mentions Region Skåne, the regional authority responsible for healthcare, public transport, infrastructure, social planning and environmental and climate-related issues, nor any civil society organization.

The results are presented under three subheadings, focusing on the importance of input (*dependence*), *trust* to get the needed input, and overall *influence* over ability to contribute to mitigate urban flood risk. To make efficient use of space in the paper, the results are simply presented in this section to inform the discussion. The key findings are summarised in the end of each subsection.

### 4.1. Importance of input

The actors within Lomma Municipality actively contributing to mitigate urban flood risk depend on different inputs to various degrees. The density[2] of the networks of each type of input varies significantly. For instance, almost seven times between *equipment and material* and *reports of activities* (Table 3). These densities are the relative prevalence of each type of *dependence*, also visualized for further analysis by the size of the dots in Fig. 3 below. This means that the contributing actors within Lomma municipality are much more dependent on *reports of activities* as a collective than on *equipment and material* to do their respective parts to mitigate flood risk.

To investigate the patterns of *dependence* of external actors, I examined the density ratio between internal and external ties. The resulting internal/external density ratio is thus a relative measure of the proportion of *dependence* on other formal actors within Lomma Municipality versus external actors, making up the y-axes in Fig. 3 below. For example, although the network of input concerning *reports of activities* has slightly higher density than *technical information*, and *advice and technical support*, they are distributed similarly between internal and external relations of Lomma Municipality (Table 3) and are very strongly correlated (0.80–0.87[3]). This means that the importance of these inputs for the whole network differs, but the proportions coming from within and outside Lomma Municipality are similar. It is also interesting to note for the following discussion that the distribution of input concerning *pepping and moral support* is twice as concentrated on internal relations as *technical information* and *advice and technical support*, and 70 per cent more concentrated than *rules and policy* (Table 3), regardless of being similar in total density. Furthermore, *pepping and moral support* and *advice and technical support* are strongly correlated (0.79[3]). Although weaker in strength than previously mentioned correlations, it is interesting to note that the network of input concerning *funding* has its strongest correlations with *pepping and moral support* (0.56[3]) and *rules and policy* (0.55[3]).

To further investigate the patterns of *dependence* between external and internal actors contributing to mitigate urban flood risk in Lomma Municipality, it is interesting to analyse the network of all inputs together (Fig. 1). To do so, I added the rated importance of each input

**Table 3**
Density and internal/external density ratio of the types of input.

| Type of input | Density | Internal/external density ratio |
|---|---|---|
| Reports of activities | 0.069 | 3.3 |
| Equipment and material | 0.010 | 3.9 |
| Funding | 0.026 | 15 |
| Technical information | 0.058 | 3.2 |
| Rules and policy | 0.056 | 4.1 |
| Advice and technical support | 0.051 | 3.4 |
| Pepping and moral support | 0.053 | 7 |

together for each pair of actors (dyad) and normalized the sum in relation to the theoretic maximum total value. This means that all nodes of the resulting network will have at least one tie and that the strength of each tie spans between 0 (no tie) and 1 (strongest possible tie).

It is then interesting to analyse the relative importance of input from different types of actors: those from within Lomma Municipality, other municipal organizations, the County Administrative Board, national authorities, private companies, universities, private citizens, and others (Fig. 2). Here it is not the density that is interesting to compare, as that is skewed by the varying number of actors in each category. Instead, the distributions of tie strengths between categories of actors were compared, and average actual tie strengths were examined for statistical significance in differences.[4] The average actual tie strength is the total normalized sum of importance of all inputs between two categories of actors divided by the actual number of ties between those categories of actors. The result of this exercise shows that the distribution of importance of input within Lomma Municipality spans the full range of the spectrum (Fig. 2), with an average slightly below the middle (0.42). The distributions of importance of input from all other categories of actors are distinctly narrower, with private companies as somewhat of an exception spanning much of the spectrum and with a similar average (0.45). Another category that sticks out as having no variance is universities, which is explained by containing only two actors being mentioned by only one respondent. As a result they were ignored in further analysis. Similarly, although with a seemingly broad distribution, the category of actors with no organization type includes only three ties to a piece of legislation, court cases, and a reference group, undermining statistical analysis. Moreover, including it in this type of analysis is not relevant as the category is without meaning in itself.

There are no statistically significant differences in averages between inputs within Lomma Municipality (0.42) and from private companies (0.45). There is no statistically significant difference from other municipal organizations (0.32), but the distribution is very different, the average lower and the median much lower, indicating that the lack of significance has to do with low number of respondents. However, the lower average importance of the input from the County Administrative Board (0.35[5]), national authorities (0.25[6]), and private citizens (0.22[7]) are statistically significant when compared to input from within Lomma Municipality and from private companies. The difference between the County Administrative Board and national authorities is also statistically significantly.[8]

To summarise, the importance of each type of input for the collective varies significantly between the seven included types (see density

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[2] The density refers to the total of all values divided by the number of possible ties [50].

[3] p = 0.0002. QAP correlation [50].

[4] Independent sample *t*-test, assuming independence in respondents' answers.

[5] p = 0.039, equal variances not assumed as Levene's test for equality of variance has Sig. 0.02.

[6] p = 0.000, equal variances not assumed as Levene's test for equality of variance has Sig. 0.006.

[7] p = 0.034, equal variance assumed as Levene's test for equality of variance has Sig. 0.059.

[8] p = 0.012, equal variance assumed as Levene's test for equality of variance has Sig. 0.955.
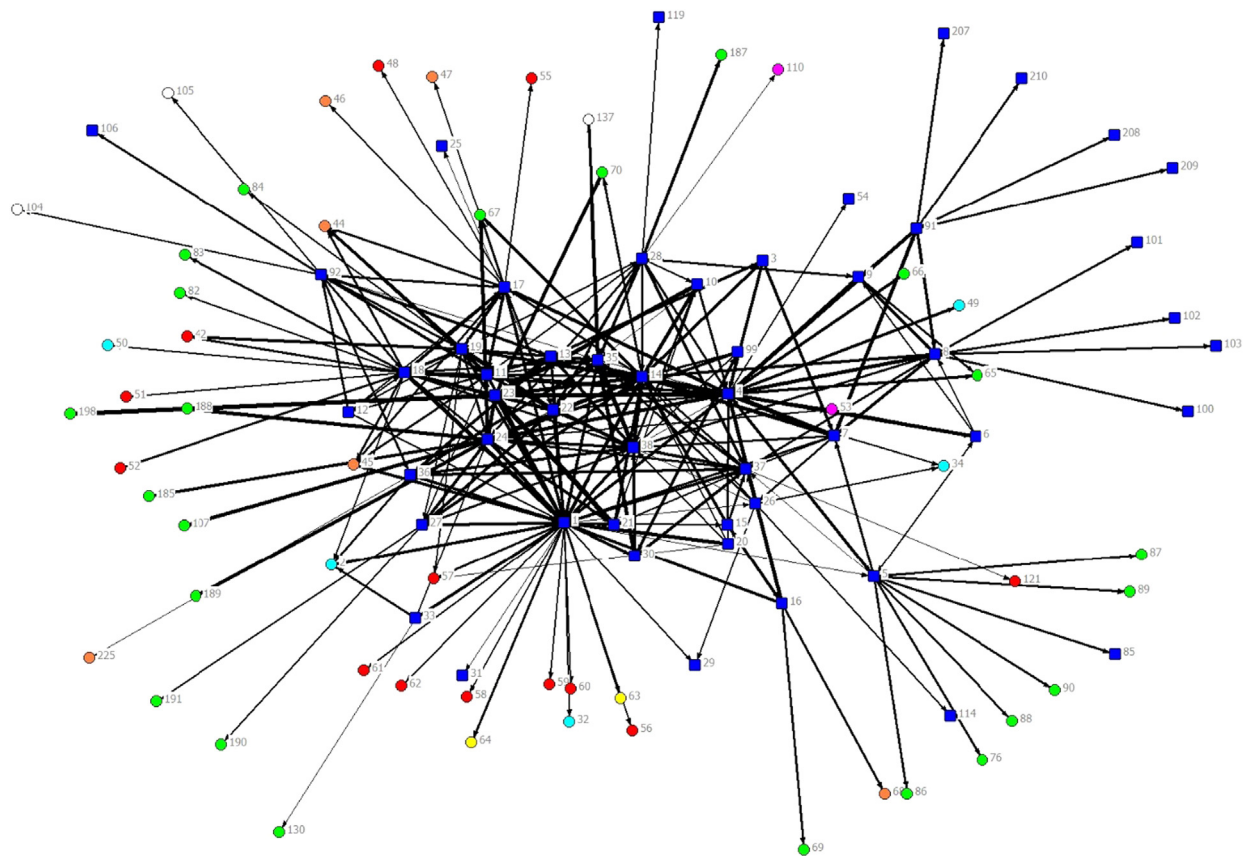
**Fig. 1.** Network of all dependencies of inputs (normalized sums of importance of the seven inputs) between formal actors by type of organization. Node colour = Type of organization (Blue = Municipality; Orange = County Administrative Board; Red = National Authority; Green = Private company; Yellow = University; Purple = Private citizens; None = White). Node shape = Lomma Municipality or not (Square = Lomma Municipality; Circle = Not Lomma Municipality). Edge thickness = Sum of importance of inputs (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.).
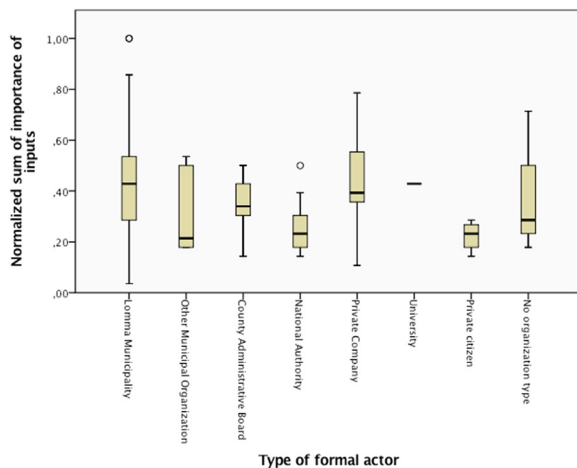


**Fig. 2.** Boxplots with the distribution of dependencies (normalized sums of importance of the seven inputs) to the respondents in Lomma Municipality divided after the type of formal actor on which they depend.

in Table 3). The relative prevalence of each type of input from internal and external actors varies also substantially (see density ratio in Table 3). When taking all seven types together, colleagues within Lomma municipality and private companies provide the most important input, with similar distributions and averages. The importance of input from the County Administrative Board is lower and from national authorities lower still (Fig. 2).

## 4.2. Trust to get the needed input

After analysing the importance of inputs to the individuals actively contributing to mitigating urban flood risk within Lomma Municipality, it is now interesting to examine the level of *trust* these actors have that they will get the input they need from the others to be able to contribute. Remembering the scale for this rating (0 = No *trust*; 1 = Little *trust*; 2 = Pretty much *trust*; 3 = Much *trust*; 4 = Full *trust*), it is interesting to find very high levels of *trust* on average within the municipality (3.27) and to other municipal organizations (3.20). The difference is not statistically significant (assuming independence in respondents' answers). The Private citizens' score was seemingly lower on average (2.50), but the difference is not statistically significant. However, in comparison to within Lomma Municipality, average *trust* is lower but still high for private companies (2.89[9]) and the County Administrative Board (2.83[10]), and much lower for national authorities (1.88[11]). National authorities also score significantly lower in comparison with the County Administrative Board[12] and private companies.[13]

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[9] p = 0.001, equal variances not assumed as Levene's test for equality of variance has Sig. 0.000.

[10] p = 0.003, equal variances not assumed as Levene's test for equality of variance has Sig. 0.002.

[11] p = 0.000, equal variances assumed as Levene's test for equality of variance has Sig. 0.4.

[12] p = 0.012, equal variance assumed as Levene's test for equality of variance has Sig. 0.955.

[13] p = 0.000, equal variance not assumed as Levene's test for equality of variance has Sig. 0.001.

*Trust* correlates very strongly with the type of *relationship* the actors have with each other (0.93[14]), meaning that the better friends they are, the more *trust* they express. There is a strong association between *trust* (dependent variable) and the seven different inputs (independent variables), in total ($R^2 = 0.85$[15]), with *pepping and moral support* having the strongest effect in the regression model ($\beta = 0.45$), followed by *reports of activities* ($\beta = 0.31$), *rules and policy* with ($\beta = 0.22$), *technical information* ($\beta = 0.19$), *advice and technical support* ($\beta = 0.13$), and *funding* ($\beta = 0.13$). *Equipment and material* has a relatively weak negative effect on *trust* in the regression model ($\beta = -0.20$), meaning that the more important that input is for the respondents, the lower *trust* they will have that they would get what they need to contribute to mitigating urban flood risk. This is not surprising considering the very strong correlation between *trust* and *relationship*. There is also strong association between type of *relationship* (dependent variable) and the seven different inputs (independent variables) in total ($R^2 = 0.84$[15]), but with differently distributed regression coefficients ($\beta$). Again, *pepping and moral support* has the strongest effect in the regression model ($\beta = 0.49$), followed by *reports of activities* ($\beta = 0.22$), but with twice the difference in relative importance between the two. *Advice and technical support* ($\beta = 0.15$) and *funding* ($\beta = 0.13$) are roughly as important in both regression models, and *equipment and material* has again a negative effect, but here only half as strong ($\beta = -0.11$). However, the most substantial differences are found for *rules and policy*, with only an eleventh of the importance compared to above ($\beta = 0.02$), and for *technical information*, with around a third of the relative importance ($\beta = 0.06$). The regression coefficients form the x-axes in Fig. 3 to inform the discussion.

It is important to note that there is a substantial difference in distribution of type of *relationships* internally within Lomma Municipality and with external actors, with statistically significant difference in average (2.42 vs 1.32[16]). This means that the respondents are more likely to know other actors within the municipality well or to be friends with them than actors outside the municipality.

To summarise, the respondents have very high levels of *trust* that they will get what they need from their colleagues within Lomma Municipality, lower but still high *trust* for private companies and the County Administrative Board, and much lower for national authorities. *Trust* correlates very strongly with level of friendship and has a strong association with the seven different inputs. There is also strong association between type of *relationship* and the seven different inputs, but with different importance of the types of input (Fig. 3).

### 4.3. Influence over ability to contribute to mitigating urban flood risk

Finally, it is interesting to examine the *influence* actors feel others have over their ability to contribute in general. Again, using a five-step scale (0 = No *influence*; 1 = Little *influence*; 2 = Pretty much *influence*; 3 = Much *influence*; 4 = Extreme *influence*), the average stated that there is an *influence* span from 'much *influence*' towards 'pretty much *influence*' for national authorities (3.00), county administrative boards (2.92), private companies (2.85), within the municipality (2.65), other municipal organizations (2.20). It is interesting to note that national authorities are rated high here. However, there are no significant differences in the average stated *influence* between any of these different groups (assuming independence in respondents' answers). However, there is strong association between *influence* (dependent variable) and the seven different inputs (independent variables) in total ($R^2 = 0.87$[15]), but with *reports of activities* having the strongest effect in the

regression model ($\beta = 0.43$), followed by *rules and policy* with ($\beta = 0.31$) and *funding* ($\beta = 0.30$). *Technical information* ($\beta = 0.16$), *advice and technical support* ($\beta = 0.08$), and *pepping and moral support* ($\beta = 0.08$) have less effect, and *equipment and material* has a relatively weak negative effect on *influence* in the regression model ($\beta = -0.16$). The regression coefficients are again plotted on the corresponding x-axis in Fig. 3 to inform the discussion.

To summarise, very different from *dependence* and *trust*, the respondents state as a collective that national authorities, the County Administrative Board, and private companies have all much *influence* over their ability to contribute to mitigate urban flood risk. There is again a strong association between *influence* and the seven types of input, but with very different types of inputs being most important (Fig. 3).

Fig. 3 is made up of three diagrams, focusing on the type of *relationship* (top left), *trust* (top right), and *influence* (bottom). The y-axes represent the internal/external density ratio for each of the types of input. It is a relative measure and means that the lower a dot is located, the bigger share of the importance of that input comes from external actors. The size of the dots represents the relative prevalence of each input (density), meaning that a larger dot signifies that the contributing actors within Lomma municipality are more dependent on that input as a collective. Finally, the x-axes represent the regression coefficients for each of the three regression models above, meaning that a dot further away from the y-axis has a stronger effect on the type of *relationship*, *trust*, and *influence*, respectively.

## 5. Discussion

It is apparent that the municipality is highly dependent on input from various external actors to mitigate urban flood risk. This is fully in line with the principal notion of risk governance [5]. However, interesting patterns emerge with regard to what types of input are more prevalent than others. Although the *dependence* on all types of input are more concentrated internally, external actors contribute with larger shares of inputs with more technical and informational characters (solid blue dots in Fig. 3). It is also these three types of input that correlate strongest with each other, but there is a key distinction between them concerning the role of personal relationships for each. Exchanging *technical information* entails relatively little concern of personal relationships, while asking for *advice and technical support* involves somewhat more consideration of how well actors know each other. Oddly enough at first glance, the *report of activities* connotes an even stronger association with the type of *relationship* the actors have. However, getting reports of implemented activities include long-term relationships of manager/co-worker and with some more deeply involved external actors, with the result of them getting to know each other. In contrast, external actors contribute with much smaller shares to more emotional inputs. This could perhaps be expected considering common notions of collegial support and the softer sides of management within organizations [cf. 51], but it further highlights the importance of friendship in the mitigation of urban flood risk. The analysis shows that *pepping and moral support* is eight times more strongly associated with friendship than *technical information*, and that friendship is much more prevalent within Lomma Municipality than with external actors. It is then interesting that the financial input of *funding*, which is more than twice as concentrated internally than *pepping and moral support*, has among the weakest associations with type of personal *relationship*. Similarly, although being only somewhat more concentrated internally within Lomma Municipality than the technical inputs above, the normative input of *rules and policy* instructing the respondents on what to do is of least relative importance for the personal *relationship* between actors. This is a clear indication that being dependent on financial or normative input from someone is not conducive to close personal relationships.

Although being significant in itself, friendship becomes even more

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[14] p = 0.0002. QAP correlation [50].

[15] p = 0.0005. Multiple regression QAP via double Dekker semi-partialling [50]. 2000 permutations.

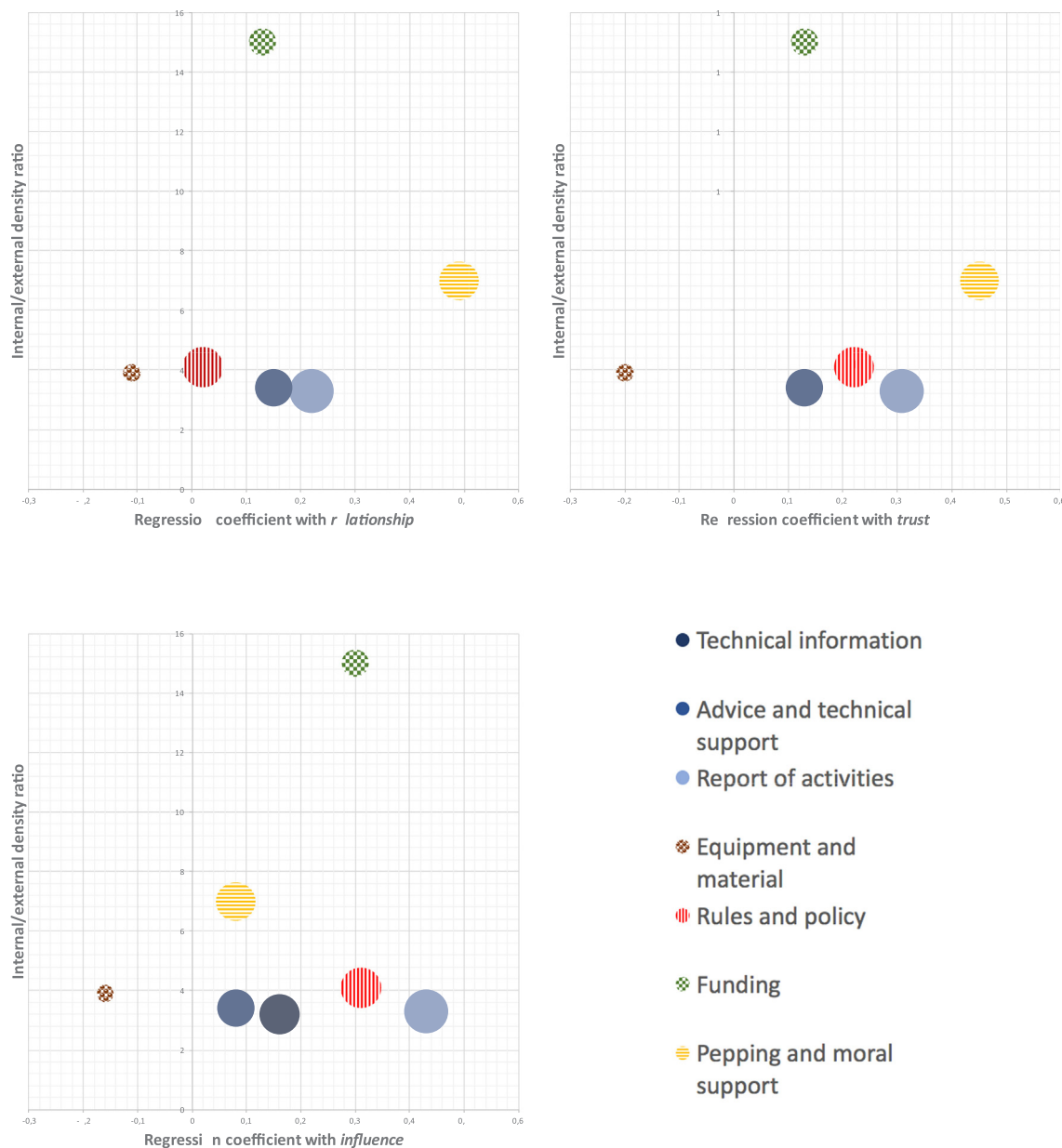[16] p = 0.000, equal variance not assumed as Levene's test for equality of variance has Sig. 0.000.

**Fig. 3.** Overview of the proportions of internal/external shares of different inputs and their association with types of relationships, trust, and influence. Size = Relative prevalence (density).

important in relation to the *trust* that the respondents have that they would get what they need from the actors they depend on. Friendship and *trust* have a very strong correlation, which is a common theme in established theory [40,52]. It is again the emotional input of *pepping and moral support* that has the highest relative importance for *trust* by far, but with a smaller gap to *report of activities* again on second place (Fig. 3). However, the most significant differences are the leap in relative importance by the normative input of *rules and policy* up to third place, and *technical information* surpassing both *funding*, and *advice and technical support*. It is thus not only clear that friendship is fundamental for *trust* in mitigating urban flood risk, but also that there are other factors at play that might be helpful to phrase in relation to authority. First of all, the importance of normative input corresponds closely to Weber's [43] legal authority, which is based on the acceptance of the rules, regulations, and other institutions granting authority to particular actors. It is fundamental for *trust* in modern society [39]. Similarly, the importance of technical input for *trust* relates closely to what Wrong [44] refers to as competent authority, which is based on the *trust* in

expert knowledge, which is another fundamental consequence of modernity [52].

It is also interesting to note that the emotional input so important for the type of personal *relationship* and *trust* between actors is of little importance for the overall *influence* over their ability to contribute to mitigate urban flood risk (Fig. 3). Normative input is again important, which is reasonable considering that *rules and policy* are intended to determine or guide activities in general. More interestingly, financial input is suddenly important, after having more marginal effects on type of personal *relationship* and *trust*. Providing *funding* is, in other words, associated with *influence*, which is another common theme in literature [37] that seems applicable to the social organization of actors contributing to mitigate urban flood risk. Both normative and financial inputs have in a sense a directional character from specific positions of authority, exerting *influence* over others in the network. However, *report of activities* has here even greater effect on *influence* and is much more democratically distributed. If there is a direction, it is from co-worker to manager, or from service provider to client, which most often goes in

the opposite direction of *funding* and to lesser extent *rules and policy*. This type of authority vested in the actual work of the many doers is not captured well in established typologies [e.g. 43,44]. The importance of their work has been acknowledged before [e.g. 4,5], but this study illuminates the great *influence* doers exert back on their managers, clients, or other decision-makers and funders. This resonates well with governmentality perspectives on power, where power is not only exercised hierarchically – from some powerful 'top' and 'down' – but between everybody conducting the conduct of each other [53,54]. I believe this is key to understand risk governance. Especially since *influence* is among the most prevalent from external actors.

External actors contribute with somewhat smaller shares of technical, but more tangible inputs; i.e. *equipment and material*. This input is the least prevalent in the study and has weak negative associations to type of *relationship*, *trust*, and *influence* that are difficult to grasp fully. This means that the more important the input of *equipment and material* is, the less well the respondents know each other, *trust* that they will get the overall inputs they need, and the smaller the overall *influence* the other actor has. This is explained by the tendency of respondents not to know the actors they depend on for such input. and to have less *trust* that they will get what they need the more important the input is. This is so far somewhat reasonable and could be an actual pattern of social relations. It is more difficult to understand the negative association with *influence*, which would mean that the more important input of *equipment and material* is, the less *influence* the providing actor has on the ability of the respondent to contribute to mitigate urban flood risk. Considering the much smaller prevalence of *dependence* on *equipment and material* and its weaker correlation to other variables, it is deemed prudent not to make too much of this last result.

All different types of external actors wield substantial *influence* over urban flood risk mitigation in Lomma Municipality. It seems to be the strongest for national authorities, but there are no statistically significant differences between them concerning *influence*. It is then very interesting that national authorities provide significantly less important overall input than the county administrative board, which in turn provides significantly less important input than private companies. However, the difference is even more striking when looking at the *trust* the municipality has that they will get what they need from these different external actors, with both private companies and the county administrative board enjoying relatively high and much more *trust* than national authorities. These are clear indications of a vertical decoupling between the municipality and the national level, in which the municipality experiences a lack of comprehensive and consistent direction and guidance on how to mitigate escalating urban flood risk. Direction and guidance can only come from the national level to reduce the pressure for local or regional actors to continuously reinvent the wheel. It is also interesting to note that private companies are the most important and trusted providers of input, at the same time as Sweden is traditionally considered as having a strong state that shoulders the responsibility of its citizens' safety [55]. The municipal level is still carrying this responsibility, but perhaps these results are symptoms of the ongoing deterioration of the strong state [56] and the current reshaping of the policy agenda for societal safety [55]. This policy agenda has Anglo-American roots and has been suggested as being neoliberal [57], which makes the result of this study particularly interesting and important. Especially considering that private companies are only engaged in detached bits and pieces, without the possibility of grasping the overall problem that is necessary for mitigating flood risk. This is closely related to the commoditization of societal safety in which crucial inputs to risk governance are increasingly treated as discrete products that can be procured on a market [58]. Private companies deliver such crucial input and the municipality have high trust that they will deliver what is ordered. The question that cannot be addressed by the present study is if these discrete pieces are aggregated in a way that results in safety.

It is also interesting to look at what external actors are not mentioned at all. While claiming to have a role in climate change adaptation

in the county, Region Skåne is simply not mentioned at all and appears to be irrelevant for Lomma Municipality when mitigating urban flood risk. That is not to say that Region Skåne is excluded from mitigating current and future flood risk, as they are actively involved in securing and adapting the healthcare system and other sectors for which they are responsible. Another notable feature is the complete absence of civil society organizations, in a country consistently ranked highest in Europe concerning public membership in civil society groups and networks [59,60]. Regardless of whether individual Swedes are extraordinarily organized [61], they are not organized to engage in the mitigation of urban flood risk in Lomma. A mobilizing civil society is a common response to diminishing engagement of national authorities in other countries [62,63], but it appears that citizens experience the maintained responsibility of the municipal level, with the support of private companies, as sufficient so far. Even worse, it may mean that the strong civil society in Sweden is also being weakened. Finally, no respondents mentioned anybody directly engaged in flood risk or water resource management at the municipalities upstream, whose decisions and actions definitely impact urban flood risk downstream in Lomma. There are a few links to the coordinator at Höje Å Water Council, which indirectly includes representatives of the upstream municipalities, but the question is if that is enough to bridge such a horizontal decoupling across the hydrological system of the catchment area.

## 6. Conclusion

So, what patterns of *dependence*, *trust*, and *influence* of external actors emerge in the accounts of municipal politicians and civil servants contributing to urban flood risk mitigation in Lomma Municipality, Sweden? First of all, it is evident that input from external actors is vital for the municipality. It is also clear that external actors are most important in providing input of technical and informational character, somewhat less important in providing normative input, while much less important in providing emotional input and hardly involved at all in providing financial input. The personal relationships between actors are crucial for *trust*, alongside competent authority and legal authority, which are also fundamental for understanding social organization in this context. However, the *influence* that actors have on each other when contributing to mitigating urban floor risk is not only associated with authority coming from the top down, largely based on controlling normative and financial input, but also with the authority of the many doers, regulating their actions and reporting, which is more democratically distributed and including external actors to relatively large degree.

While all the different types of external actors wield substantial *influence* over urban flood risk mitigation in Lomma Municipality, there are striking differences in the importance of the provided input and the level of *trust* within the municipality that they will provide what is needed. Most notably, there is a vertical decoupling from the national level, with national authorities providing less important input than other types of actors, and with much less *trust* that they will provide what the municipality needs from them. Private companies are instead the most important providers of input and they are more trusted that they would provide what is needed. The municipal level is still maintaining state responsibilities, but the diminished role of the national level must be addressed for effective mitigation of urban flood risk in the future. Especially in a changing climate. The contribution of private companies would still be crucial, but the municipalities need comprehensive and consistent direction and guidance to address current and future challenges. Moreover, there is a horizontal decoupling to the municipalities upstream in the Höje Å catchment area, which also has to be addressed for effective urban flood risk mitigation.

These patterns of social relationships between internal and external actors contributing to mitigate urban flood risk are important for understanding flood risk governance in society. There are obviously contextual differences that limit the generalizability of these results.

However, it is fair to assume that the findings are applicable to similar Swedish municipalities in terms of size and complexity of flood risk, and at least informative for other municipalities in Sweden. The findings are also interesting for comparison to municipalities in the other Nordic countries, which are anticipated to have similar experiences.

## Acknowledgements

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