Urban rain water management-Results of questionnaire research in Thessaloniki, Greece.

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Abstract. This paper presents results of a questionnaire research regarding public perception of flood damage or nuisance caused by rain, and attitude towards ecological rainwater management techniques. The questionnaires have been addressed mainly to residents of the central part of Thessaloniki, a major urban area of Greece. Results reveal that: a) ninety-one (91%) percent of the respondents acknowledged that there is serious problem caused even by medium rain events, b) most respondents (95%) are positive about the use of rain gardens and other ecological techniques, which mitigate the nuisance caused by inundation of streets and sidewalks during rain events and c) 76% of the respondents are not disposed to pay anything for new ecological rainwater management infrastructure to reduce the hazard, while 3% are disposed to pay 1€ more in their bills for the Thessaloniki Water Supply & Sewerage Co. S.A., 6% to pay 5€, 4% to pay 10€, and 10% to pay 20€ or more.

1. Introduction
Even in developed countries, sewer networks may fail to fully protect all parts of urban areas during heavy rain events. In such cases, water covering street surfaces and sidewalks renders their use by pedestrians or challenging task and car driving unsafe. In worst cases, shops and houses, in particular house basements, are inundated and even human lives are exposed to danger. The problem may become even more acute, due to climate change [1].

Solutions to handle such problems could be sought in the framework of integrated rainwater management, which combines sewer networks with low impact techniques, such as rain gardens and green roofs e.g. [2], [3], [4]. These solutions, which add to the sustainability of urban neighbourhoods [5], might also prove more cost efficient than sewer network upgrading [6].

In this paper, public perception of rain water problems and their proper handling is discussed. More specifically, we analyse the answers to the following questions: Do the residents acknowledge that there is serious problem caused even by medium rain events? Do they have a positive attitude towards construction of rain gardens and integration of ecological techniques to the rain water management system? Do they have the intention to economically contribute to the construction of the respective works? The research reported here gives glimpses into these important issues, thereby providing a basis of work that could be further explored through more detailed search [7].
2. Research design

The findings presented in this paper are based on a questionnaire research, which has been conducted in the city centre of Thessaloniki, Greece, during Spring of 2018. One hundred people were finally willing to participate, and they were personally interviewed. The demographic features of the participants are given in Section 3. The questionnaire consists of three main sections, summarized in Table 1. The full text is presented in Appendix A. Two photos, included in the questionnaire, appear in Figures 1 and 2.

| Table 1: The interview sections |
|-------------------------------|
| Section 1 | Age, educational level, number of family members, income, marital status, occupation, sex, municipality. |
| Section 2 | What is the most frequent itinerary, whether they encounter problems in the streets during rain events, problems with sewer inlets, troubles and risk for drivers or pedestrians, which are the most problematic streets. |
| Section 3 | If they agree with the construction of rain gardens and other ecological infrastructure, if they are willing to support economically these constructions and how much, the amount that they pay in their accounts for the Thessaloniki Water Supply & Sewerage Co. S.A., if they know that a part of their bills corresponds to sewage system network, which sewer-related works should be given priority. |

3. Results

3.1. Participant Demographics

As shown in Table 2, overall, the participants interviewed for this research were highly educated, namely 82% held a Bachelor’s degree or higher. Moreover, they were almost evenly distributed, regarding sex (female 52% - male 48%). Regarding marital status, the sample seems representative, as well. It is slightly biased towards younger ages, though, as 54% of the participants was between 20-40 years old. Finally, as far as income is concerned, it can be considered as representative, given the financial situation in Greece.

| Table 2: Participant Demographics |
|----------------------------------|
| DEMOGRAPHIC CATEGORY | RESEARCH PARTICIPANTS 2018 DEMOGRAPHIC SURVEY |
Population/research participants: 100
Male/Female: 48% / 52%
Bachelor's degree or higher: 82%
Age: 20-40/ >40: 54% / 46%
Married/Unmarried/Divorced: 52% / 43% / 5%
Average household income (up to 10,000): 50%
Municipality (Thessaloniki): 64%

3.2. Problems during rain events
The answers of the questionnaire-participants confirmed that the sewage system of Thessaloniki fails to protect many parts of the urban area during intense rainfalls. The vast majority (91%) answered that intense rain events constitute a hazard, both for pedestrians and car drivers, while 63% reported that they have encountered serious problems, during such events. Finally, according to their responses, the most serious problems appear in the streets Egnatia, Ag. Dimitriou, Ethnikis Aminis and Svolou. Results are summarized in Table 3. It is worth mentioning that Ethnikis Aminis Street has a comparatively large slope and concentrates rain runoff from a rather large area, while the other three have small longitudinal slope, but they receive rain runoff at junctions with large slope streets.

Table 3: Streets with severe inundation problems

| MOST PROBLEMATIC STREET | NUMBER OF PARTICIPANTS | PERCENTAGE OF TOTAL |
|-------------------------|------------------------|---------------------|
| Egnatia                 | 22                     | 22%                 |
| Ag.Dimitriou            | 22                     | 22%                 |
| EthnikisAminis          | 19                     | 19%                 |
| Svolou                  | 19                     | 19%                 |
| Tsimiski                | 9                      | 9%                  |
| Nikis                   | 3                      | 3%                  |
| Aggelaki                | 2                      | 2%                  |
| Aristotelous            | 2                      | 2%                  |
| Iasonidou               | 1                      | 1%                  |
| P.Patron                | 1                      | 1%                  |

3.3. Rain gardens and other ecological methods: Perception and attitudes
Answers regarding participants’ attitude towards environmentally friendly rain water management techniques and their willingness to pay for them, are summarized in Table 4. According to Table 4 almost all participants (95%) had positive attitude towards construction of rain gardens and other ecological methods and consider the new infrastructure as necessary. Nevertheless, they vast majority (76%) is not willing to pay anything about these projects (76%). The 10%, which is willing to pay 20€ or more, is also remarkable.
Table 4: Participant perception and attitudes

| WILLINGNESS TO PAY | NUMBER PARTICIPANTS | OF TOTAL | PERCENT OF TOTAL |
|--------------------|---------------------|----------|------------------|
| Positive opinion about construction | 95 | 95% | |
| Not disposed to pay anything | 76 | 76% | |
| Disposed to pay 1€ | 3 | 3% | |
| Disposed to pay 5€ | 6 | 6% | |
| Disposed to pay 10€ | 4 | 4% | |
| Disposed to pay 20€ or more | 10 | 10% | |

Responses regarding priorities of works aiming at improvement of the overall sewer system are summarized in Table 5. The participants could select more than one option. Their first 2 choices were added to the count for each option. For this reason, the sum of the percentages appearing in the last column of the Table exceeds 100.

It can be seen that integration of ecological methods falls behind maintenance of the sewer network and of the construction of new pipes. This partly explains the low willingness to pay, shown in Table 4.

Table 5: Priorities of works aiming to improve the sewer system.

| PRIORITIES OF NEW PROJECTS | NUMBER PARTICIPANTS | OF TOTAL | PERCENT OF TOTAL |
|----------------------------|---------------------|----------|------------------|
| A. Sewer system network maintenance | 72 | 72% | |
| B. Construction of new sewer pipes | 35 | 35% | |
| C. Integration of ecological methods | 22 | 22% | |
| D. Improvement of water treatment plant | 21 | 21% | |
| E. Improvement of sewer network monitoring | 20 | 20% | |

The questionnaire included two control questions, as well, regarding bills paid to the Thessaloniki Water Supply & Sewerage Co. S.A. Answers to the first, regarding the amount paid every 4 months, are presented in Table 6. The bills are rather low, compared to those of other utilities, as only 21% pay more than 60€.

Answers to the second control question indicate that the majority (77%) is aware that part of the amount corresponds to sewer services.

Table 6: Bills paid to the Thessaloniki Water Supply & Sewerage Co.

| AMOUNT PAID | NUMBER OF PARTICIPANTS | PERCENT OF TOTAL |
|-------------|------------------------|------------------|
| 30-40€ | 41 | 41% |
| 40-50€ | 24 | 24% |
| 50-60€ | 14 | 14% |
| More than 60€ | 21 | 21% |

4. Discussion and Conclusions

The research presented at this paper has been conducted in an urban area, which suffers from insufficient rain-runoff management, according to the perception of the authors. Its aim was to investigate: a) Public perception regarding rain-runoff hazard and b) public attitude towards rain gardens and other ecological rainwater management techniques. Implicitly, it served as an awareness raising tool, as well.
Selection of participants was random. Nevertheless, the sample can be considered as representative regarding certain parameters, such as sex, marital status and income. It exhibited some bias, though, towards young age and high educational level.

According to the results, ninety-one (91%) percent of the respondents acknowledged that there is serious problem during rain events and indicated highly problematic streets in a consistent way. Moreover, most respondents (95%) had a positive attitude towards construction of rain gardens and application of other ecological rain water management methods.

Nevertheless, willingness to pay for their application was too low, as the vast majority (76%) was not eager to contribute even the smallest sum. This result was rather disappointing, in particular when combined with high awareness of the problem, rather young age and above average educational level of the participants.

This research might serve as a basis for further study in different contexts and different parts of the major area of Thessaloniki. Influence of sample selection on the outcome should be investigated, as well.

Appendix A

QUESTIONNAIRE INVESTIGATION OF RAIN WATER MANAGEMENT IN THESSALONIKI

Social characteristics of the respondent

1) Region
2) Municipality
3) Family size
4) Educational level:
   a) Secondary school graduate
   b) High school graduate
   c) University Student
   d) University graduate
5) Main profession
6) Marital status
7) Age
8) Sex
9) Income

Problems during rain events

10) Which is your usual itinerary?
11) Have you noticed any problems in streets during rain events?
12) Have you noticed any blocked inlets to the sewer system along streets?
13) How severe are the problems that you encounter as pedestrian or as car driver during rain events?
14) Does heavy rain constitute a hazard for pedestrians and car drivers?
15) In which streets have you noticed the most severe problems during rain events?

Attitude towards ecological rain water management

16) Do you agree with integration of ecological rain water management techniques in the drainage system?
17) If you agree, are you willing to contribute financially to the construction of the necessary works in Thessaloniki?
18) If you consider these works useful, what amount would you be willing to pay?
19) Which projects regarding the overall sewer system should be given priority by the pertinent authorities?

Control questions

20) How much do you pay for water supply bills?
21) Do you know that part of this amount is for sewerage?

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