Living and adapting to climate change in coastal areas.
A case study on citizens' perception of an infrastructure: the MOSE in Venice

Bruno MAGGI

R&D Consultant, Milan, Italy
E-mail: bmaggi59@gmail.com

LIVING AND ADAPTING TO CLIMATE CHANGE IN COASTAL AREAS.
A CASE STUDY ON CITIZENS' PERCEPTION OF AN INFRASTRUCTURE: THE MOSE IN VENICE

BRUNO MAGGI
R&D Consultant, Milan, Italy
E-mail: bmaggi59@gmail.com

Abstract

A continuous increase in water levels is being observed in the Mediterranean Sea, as well as globally. Furthermore, the trend is accelerating, and in some coastal areas the phenomenon is more evident in terms of impact on the life of the inhabitants. Between 2013 and 2021, sea level rose by 4.5 millimeters per year. The Venice lagoon, like other coastal areas, is particularly at risk as the sea level could reach 45 centimeters by 2100. The MOSE, (electromechanical experimental module), is a system of mobile dams aimed at defending the city of Venice and its lagoon. The purpose of this study is to detect the perception that coastal and non-coastal inhabitants have of this infrastructure, through a questionnaire with answers on a Likert scale submitted to subjects living in the Po Valley at different distances from Venice. We therefore want to verify the different sensitivities of the inhabitants in relation to their geographical distance from the infrastructure, returning possible correlations.

Keywords: sea level, coastal areas, infrastructure, inhabitants' perception.

1. Introduction:

We think it is useful to verify the level of perception of the problem by a group of people, qualified to provide answers suitable for comparison with what is reported by the scientific community, that deals with the rise of seas caused by ongoing climate changes. Between 2013 and 20121 sea level rose by 4.5 millimeters per year (Anzidei, 2022). This apparently insignificant data worries the international scientific community quite a bit. But now even ordinary people are starting to realize the problem that rising seas are starting to cause. The frequency of flooding in coastal areas is starting to generate awareness of the problem not only in the populations affected, but also in those who are geographically more distant from the coasts. A recent book published in Italy shows in 17 color maps how the world could become in 2872. The authors (Pievani, Varotto, 2022) recount the tour of the world undertaken a thousand years after the one described by Jules Verne in "The Around the World in 80 Days". Ferrarese[1] developed how much the seas would rise if we do nothing to mitigate global warming between now and that date, using a drawing software and geographical data calculated in the GIS context (Geographic Information System),

For example, The Po Valley could become a sea within this millennium, so that even the Venice lagoon would be completely submerged. Specifically, the authors report that In the Venice lagoon the sea level could reach 45 centimetres by 2100.

High water in Venice is part of the city's history. Starting from the last century, we thought about how to deal with the increase in this phenomenon and its ever more frequent recurrence. The design of a structure to solve this problem began in 1984. Not without delays, controversies, judicial investigations for corruption and economic waste, the MOSE was tested only in 2020. MOSE (Electromechanical experimental module) is a system of mobile dams aimed at defending the city of Venice and its lagoon. This structure is made up of four barriers, with 78 gates; two barriers at the Lido harbour, the others in Malamocco and Chioggia

(Fig.1). The steel gates are filled with water lie at the bottom in concrete housings. When they are activated, they are filled with air to rise to the surface, thanks to groups of hinges-connectors (Fig.2,3).

Fig.1: The harbour inlets of the Venice Lagoon
where the mobile gates are located.
(www.mosevenezia.eu)

[1] Francesco Ferrarese (Geographic Information System, Department of Historical, Geographical and Ancient Sciences, University of Padua) developed the maps for the book "Il giro del mondo nell'Antropocene" (Pievani, Varotto, 2022).
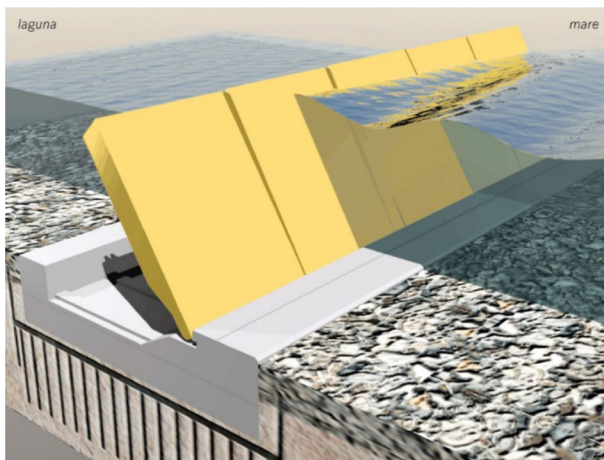

Fig. 2: MOSE: operating diagram.
(www.iitaly.org)

Fig.3: MOSE in operation.
(www.mosevenezia.eu)

The MOSE was designed to defend the Venice lagoon from tides up to 3 m high and its entry into operation was planned in anticipation of tides exceeding 110 cm. However, having only recently come into operation with the first lift on October 3, 2020, MOSE is already under stress. The barriers have gone up 13 times in 18 days between late October and early November 2023.

In light of this experience which is involving public opinion, we decided to collect the opinions of selected people among LinkedIn personal contact, involved both as inhabitants and with technical knowledge regarding the rise of the seas and the infrastructures needed to defend them, with a specific focus on the MOSE.

2. The case study

2.1 Objectives

Objectives of the study was to detect the perception that coastal and non-coastal inhabitants have of MOSE infrastructure, and how worried they are about rising seas, and also to verify the different sensitivities of the inhabitants in relation to their geographical distance from the infrastructure, returning possible correlations

2.2 Methodology

The survey instrument chosen was a questionnaire with multiple responses on a 5-score Likert scale to investigate the following dimensions of problem perception:

a) perception concern about the problem of rising seas.

b) usefulness of technological infrastructures to contain the problem.

c) perception of usefulness of the MOSE (mobile dam system aimed at defending the city of Venice and its lagoon).

N 5 questions were asked for each of sections a, b, c; N 1 open question for comments. Answers in 5 scores: 1: no way, 2: little, 3; sufficiently, 4: enough, 5: very.

a) HOW WORRIED ARE YOU ABOUT RISING SEAS?

a1) According to various studies, confirmed by scientific evidence at a global level, sea levels are increasingly rising.

a2) In the Mediterranean Sea between 2013 and 2021 sea level increased by 4.5 millimetres per year.

a3) In Venice the average sea level could rise by 72 centimetres.

a4) In the most favourable scenario by 2100 the increase in the average sea level in Venice could reach 45 centimetres.

a5) In the most pessimistic scenario, however, it could rise up to 84 centimetres compared to that of 2005.

b) HOW USEFUL ARE THE TECHNOLOGICAL WORKS TO CONTAIN THE PROBLEM OF RISING SEAS?

b1) At a planetary level.

b2) At national level.

b3) According to local needs.

b4) Made with respect for the environment.

b5) Made according to the needs of maintaining settlements and human activities.

c) HOW USEFUL IS THE MOSE (system of mobile dams aimed at defending the city of Venice and its lagoon)?

c1) For the defence against high water in Venice in today's situation.

c2) In 5-10 years.

c3) In 2100.

c4) For the defence against the advance of the Adriatic Sea in the area of the metropolitan city of Venice (44 municipalities).

c5) For the defence against the advance of the Adriatic Sea in the Po valley.

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Open question: Now, if you wish to add your reflections, advice and anything else on the topics covered, write below what you consider useful to complete and personalize your opinions. Thank you.

2.3 Participants

N 67 professionals and people interested in the topic, living in the Po valley, agreed to participate after sending the questionnaire with a Google form via email (Fig.4). When sending the questionnaire, we chose to address them to three geographical areas in order to be able to divide them into 3 clusters depending on the distance from Venice (Tab.1)
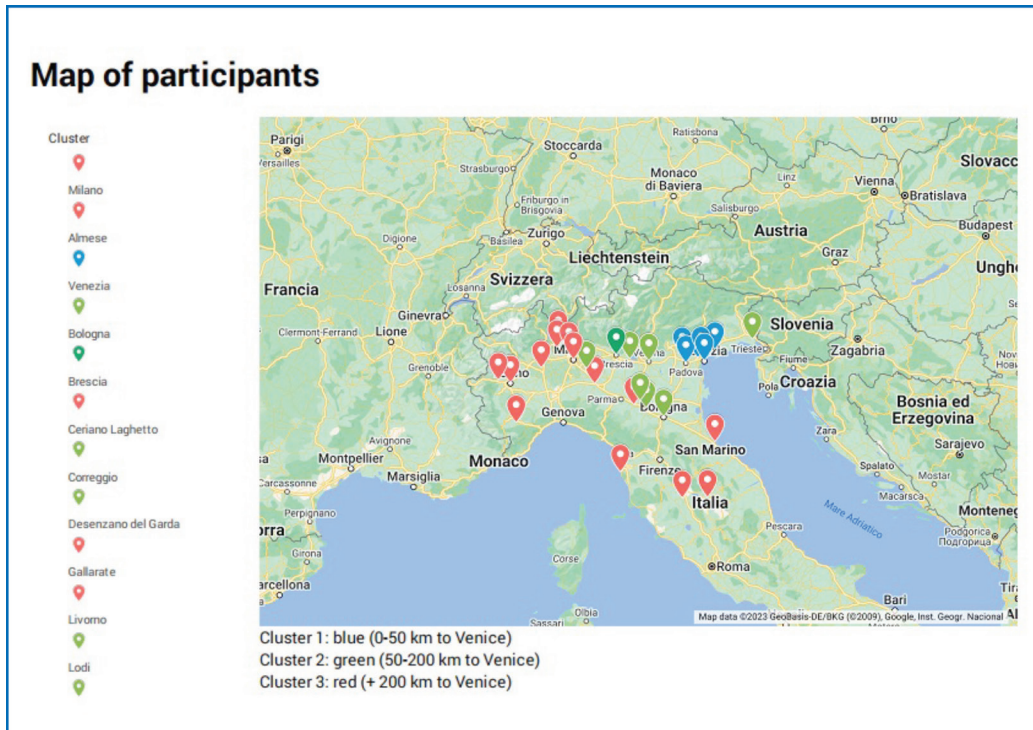

Fig.4: Map of participants.es are

Tab.1: Clustering of participants.

Cluster	Km to Venice	N	Average age	Gender	
				M	F
1	0-50	18	37	8	10
2	50-200	14	43	7	7
3	+200	35	52	20	15

In table 2 we see the participants divided by job. In our sample, managers of private companies operating in sectors related to large infrastructure and environmental engineering were most represented (20 of 67), followed by engineers (8), architects (7), university students and retired (5), consultants and geologists (4), PhD student and research fellowship (3), graduate and university professor (2), biologist, employee, environmental economist and teacher (1). Ultimately, we can group the participants into private company operators (20, 29.85%), education (16, 23.88%), independent professionals (25, 37.31%) and others (6, 8.95%).

Tab.2: Employment of participants.
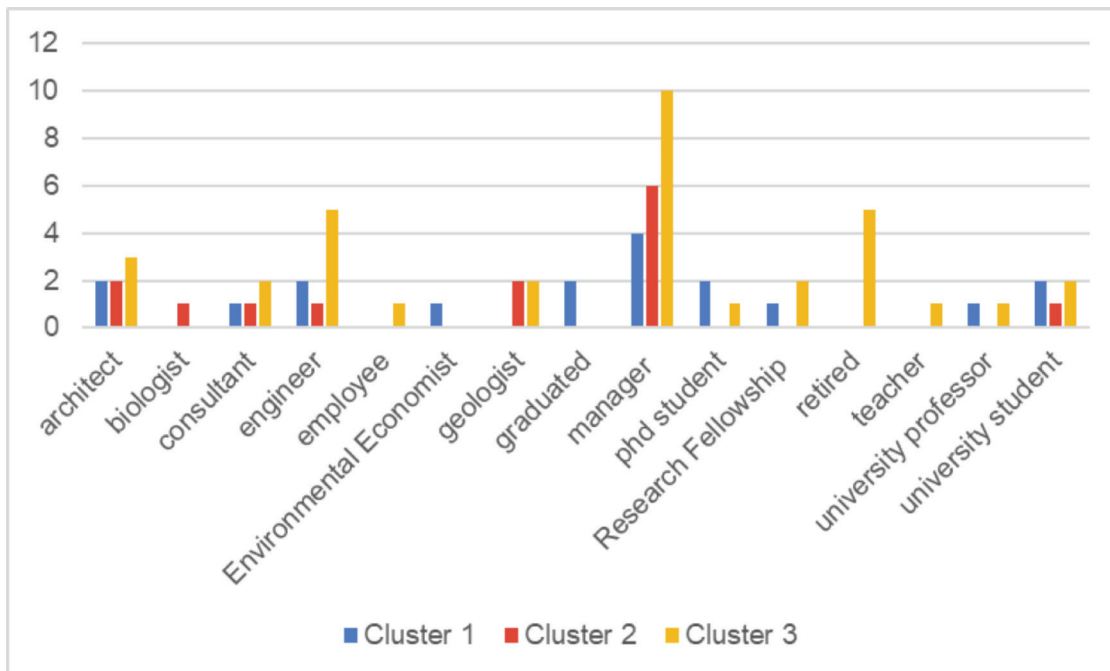
2.4 Data analysis

The data analysis was developed using an Excel sheet generated by a Google form. The average and standard deviation of the scores were calculated for each group of questions (a,b,c) in relation to the clusters (1,2,3).

As reported previously in point 2.1, the following scores were attributed to the responses: 1: no way, 2: little, 3; sufficiently, 4: enough, 5: very.

The last question was open for the comments.

3. Results and Discussion

3.1 Likert scale responses

Table 3 shows the results in the form of a statistical average, and Table 4 in graphic.

Tab. 3: Average scores and standard deviations
for clusters and groups of questions.

		CLUSTERS		
		(Km to Venice)		
	GROUP OF QUESTIONS	1 (0-50)	2 (50-200)	3 (+200)
a	How worried are you about rising seas	4.291; *0.77*	4.242; *0.87*	4.196; *0.94*
b	How useful are technological infrastructure	3.407; *1.06*	3.374; *1.08*	3.346; *1.10*
c	How useful is the MOSE	3.107; *1.13*	3.080; *1,14*	3.053; *1.15*

Tab. 4: Average scores in graphic for clusters and groups of questions.
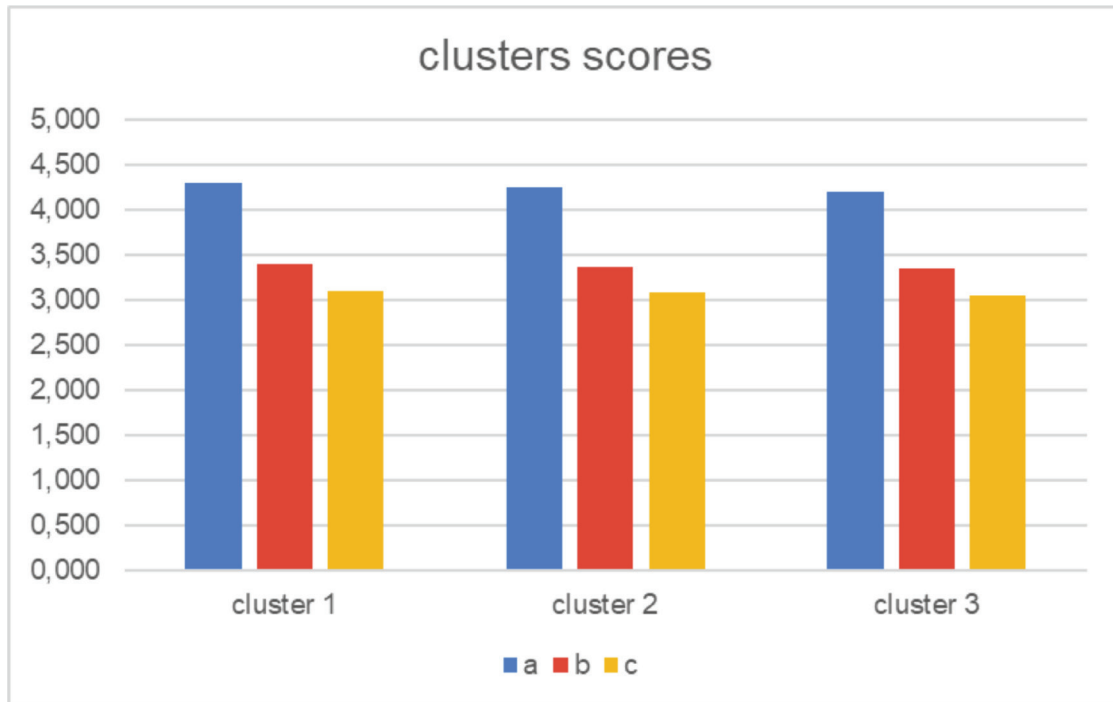
3.2 Answers to the open question

N 24/67 participants provided their comments (35.8%). Looking in detail at the clusters we also notice in this analysis the trend found in the previous quantitative analysis: the responses from cluster 1 are in fact more numerous, N 8/18 (44.4%), compared to 2, N 5/14 (35.7%) and 3, N 11/35 (31.4%). We do not report all the comments here in full, postponing this reading to a possible future qualitative analysis. We can instead cite a short description of themes that emerged for each cluster of participants (Tab. 5)

Tab. 5: Main themes that emerged from the open question.

CLUSTER 1	CLUSTER 2	CLUSTER 3
Evidence of the relationship between climate change and water rise.	The concern about rising seas, in a broad sense, is understandable and emotionally relevant, but useless, since the phenomenon has never been and will not be anthropically governable.	A global strategy financed by both private companies and governments is needed.
Greater public awareness and effective communication are needed.	The technological works seem completely insufficient, a reversal of the trend in the dynamics relating to heating is needed	We need a global commitment to decarbonize human activities.
The actions of eco terrorists are useless.	We need to create a culture of environmental sustainability	We need to invest more in green barriers along the coasts.
Venice has always been used to experimenting with strategies of coexistence with the lagoon environment. The technical aspect is the most solvable.		What happened in the management of the MOSE implementation phase (timing, speculation, etc.) certainly did not help to increase the level of general sensitivity and the perception of the real risks involved.
The MOSE is a fixed but temporary structure that will need to be modified as the high-water phenomenon intensifies.	Works like the MOSE are useful, yes, but they are often designed for contingencies and short times of a few years or at most a few decades.	The MOSE is fine in the immediate future, but rising seas are unstoppable.
The MOSE is useful today, but in the future, it will have to be adapted as rising waters worsen.		MOSE is obsolete due to climate change.
The MOSE does not respond to real and current needs.		

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4. Conclusion

The reading of the data appears better highlighted by the histogram graph, where we can see that cluster 1 (0-50 km from Venice) has relatively higher scores in all three groups of questions. We can trivially interpret this result from the fact that these inhabitants are closer to the coast and to the MOSE. Nevertheless, from reading the comments left by the participants in the open question we can in the first instance draw some other indications which will be investigated in a future desirable qualitative study from which possible interpretations can be extracted. In our opinion, this further data could hypothesize a greater interest in the problem on the part of participants close to the coast (cluster 1), compared to the other two clusters. The usefulness of this study would therefore lead to identifying the participants who provided their notes and proposing an interview with them to delve deeper into the topics.

Bibliography and website.

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