***Title**:* Exploring the Impact of Water-Related Disasters on Innovation Performance in Water Management and Technology

Summary

Climate change is producing more and more extreme weather events. These events make us more dependent on green technologies' adaptations to such extreme events. In this report, we assess the impact? of past extreme weather events on the likelihood of European Regions producing more green technologies related to water management, flood adaptation and water-related appliances.

Introduction:

In recent years, there has been an escalation in the frequency and intensity of water-related disasters, such as floods due to heavy and extreme rainfall, snowmelt or rising sea levels. According to The Intergovernmental Panel on Climate Change, more precipitation has occurred since at least the 1970s. Moreover, heavy precipitation has likely increased on the continental scale over three continents, Europe included. This, in turn, has stressed the urgent need for innovative water management and technology solutions.

From 1950 to 2016, a dataset compiling water-related calamities across various EU countries recorded 1,141 events, including floods caused by heavy and extreme rains and snowmelts. The total losses during this period were estimated at 219 billion euros (in 2016 prices), killing 7,998 people and directly affecting over 100,000 people across 270 NUTS2 regions.

Many studies argue that natural disasters are primarily a consequence? of underdevelopment, as less-developed areas often lack preventive measures and adequate infrastructure, making them more vulnerable. Generally, disaster damages decrease with economic development and wealth, which help protect lives and property. However, as more economic growth brings more value to infrastructure and capital, those goods are at a higher risk of high damage when a climate calamity occurs. In fact, recent extreme weather events, caused significant losses in affluent areas, showing that economic development alone is not enough[1]. Higher income does not always equate to better protection from natural hazards. However, adaptive measures, including existing mitigating technologies and new innovations, are essential to reduce disaster impacts and build resilience. While there is a link between past disaster damage and the emergence of mitigating technologies, innovation as an adaptive response to natural disasters remains poorly understood.

An innovation is the first practical application of an invention. It often takes a significant amount of time for an invention of a process or product to become an innovation. Innovations typically happen in firms that combine various knowledge, skills, and resources to bring inventions to the market. On the other hand, inventions occur in places like universities, research institutes, companies, and public organisations.

Studies on natural disasters show that risk perception affects risk reduction behaviours and preparedness. Additionally, prior disaster experiences increase risk perception and positively impact self-protection decisions. In summary, awareness and experiences of past disasters enhance perceived risks, prompting self-protective actions.

The theory of innovation in response to natural disasters suggests that a disaster increases perceived risks and boosts demand for adaptive technologies. This demand motivates the private sector to develop newer, cost-effective technologies to mitigate future disaster impacts. However, the theory often overlooks the crucial link of how and why, mostly the private sector and, on a smaller scale, other institutions respond to this rising demand. Understanding this link is essential for identifying the geographical scope of innovation and designing effective public policies.

Expected profitability is the key link between rising demand and innovation response. Increased demand for impact-reducing technologies creates profit incentives, prompting the private sector

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[1] Fig. 2 below shows the upward trend in losses of millions of Euros while Fig. 3 and Fig. 4 show a decline in people affected and killed in these kind of events. It seems to be the case that although more events and more billionaire losses in EUR are being recorded, the number of people affected and killed would be following the opposite trend.

to develop effective solutions. Consequently, a disaster in one location can spur innovation from potential inventors globally, regardless of their proximity to the affected area.

As floods are exogenous events that can occur in any region despite the internal factors inherent to those regions, they can also occur in different regions regardless of the proximity. For instance, heavy rainfall in the upper Mass River in East France can cause a flood in the Mass Delta itself and, therefore, spur innovation in that region despite the more than 500 kilometres of separation between the two regions.

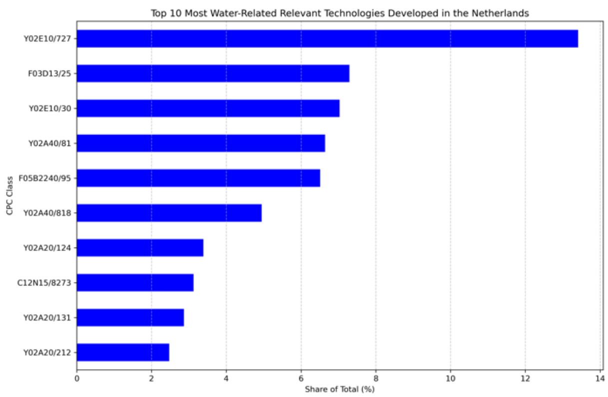
Box 1: The case of the Dutch Delta Works:

The Dutch Delta Works

- The Netherlands is the perfect example of a country that has a long history of battling sea level rise and flooding due to its depressed? geography. Climate change has exacerbated these issues, and therefore more innovative solutions to protect the country from the increasing risk of severe flooding are needed.

Technologies:

- Storm Surge Barriers: The Delta Works includes several storm surge barriers, such as the Maeslantkering and the Oosterscheldekering. These barriers can be closed during high tides and storm surges to protect the inland areas from flooding.
- Dikes and Dams: The Delta Works also features a network of reinforced dikes and dams that help manage water levels and protect against the sea.



- Top Techs in the Netherlands: In the top most water-related relevant technologies developed in the Netherlands we find offshore wind turbines and its mounting and assembling offshore, energy generation from the sea, surge barriers, and water desalination technologies.

Impact:

- The Delta Works have significantly reduced the risk of flooding in the Netherlands, safeguarding both human lives and economic activities, therefore reducing the losses of million of Euros.
- This system has also become a model of engineering and water management innovation, influencing similar projects worldwide.

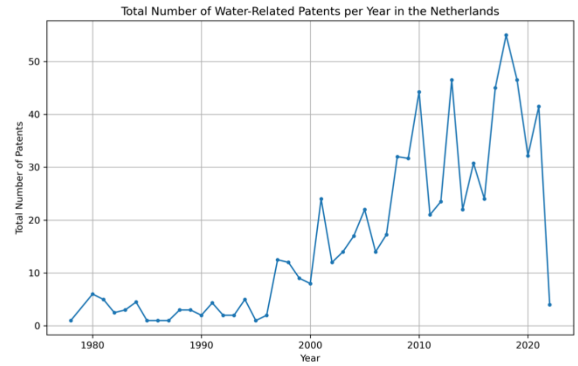
Climate Adaptation:

- The Delta Works are a prime example of how climate change has driven innovation in water management. The project not only addresses immediate flood risks but also incorporates long-term planning to adapt to future climate scenarios.

Continued Innovation:

- The Dutch continue to innovate in water management with projects like "Room for the River," which involves creating more space for rivers to flood safely, and the development of floating homes and infrastructure to adapt to rising water levels.

- In this graph it can be seen an upward trend on the filling of patents in water-related technologies in the Netherlands (as per March 2024).



In this report, we test the relationship between climate calamities related to floods and heavy rains and the likelihood of those regions being affected to create water-related technologies.
It’s been well documented in the literature how past events mark the behaviour of communities on the development of their own economic growth, their interactions and the development of new technologies. This concept is known as path dependence, and it is widely applied across various fields, including ecology, economics, and policy studies. The fundamental idea is that history is crucial: the current state of affairs is shaped by the specific sequence of events that led to it.

We, therefore, propose a specific mechanism on past events in each region that determine the likelihood of the affected areas by a purely exogenous phenomenon, i.e. heavy rain, on the creation of new water-related technologies. An exogenous phenomenon is something that is completely unrelated to the region's previous characteristics. Floods are generally considered exogenous to a given region because they are natural events that occur independently of human actions or local economic conditions. Their occurrence and intensity are primarily driven by climatic and geographical factors, such as rainfall, snowmelt, extreme rainfalls, river flows, and topography, which are beyond the control of individuals, firms, or governments in the affected region.
On the other hand, other events such as economic crises, the investment in R&D or the level of human capital in a given region are endogenous events because they are partly determined by local factors.

This analysis aims to shed light on the relationship between climate calamities and technological progress for enhancing the knowledge, policy implications and regional development and diversification of new green technologies, specifically those related to water-related technologies.

Data Sources:

For this report, we used a unique dataset of all the flood events reported to the European National Authorities over more than 100 years. The Hanze "pan-European database of exposure to natural hazards and damaging historical floods" was compiled in a unique dataset containing regional data on flooding events and extreme water-related weather events between 1880 and 2016. The dataset also includes the number of fatalities per event, the number of losses in millions of Euros as of 2016, and the number of people affected.

For the innovation output, we used the OECD Regpat, which is a unique dataset containing the patenting activities of all OECD countries (and also other countries) that submitted patents through the European Patent Office (EPO) or the Patent Cooperation Treatment (PCT). The richness of this dataset is that it identifies the region where all the inventions occur at the NUTS 3 level[2].

To retrieve the water-related patents, we used the CPC[3] classification of each patent and filtered out all the patents belonging to the so-called "ENVTECH" technologies. This is a codebook designed by the OECD to categorise all the patents tackling environmental technologies. We retrieved only the patents related to water from that list, such as devices for desalination, hydroelectric technologies, water management, water recollection, water conservation, etc.

After filtering out all the CPC codes related to water-technologies patents, we ended up with around 11.000 patents from 1975 to 2023 on around 270 NUTS 2 regions and 32 countries, including the EU, the EFTA and the United Kingdom.

[2] NUTS is the standard nomenclature for units of statistical analyses in Europe. It is used by the OECD as well as by the European Commission. In this analysis, we used the NUTS 2 level, corresponding to medium-sized European regions (for instance, provinces in the Netherlands and Bundeslands in Germany).

[3] CPC refers to the Cooperative Patent Classification, a harmonised codebook of technologies jointly managed by the US Patent and Trademark Office and EPO. The CPC tag is typically allocated by an examiner in the application office to classify a given patent in the most accurate technology class.

Fig. 1 shows the total number of water-related patents filled in European regions between 1976 and 2023.

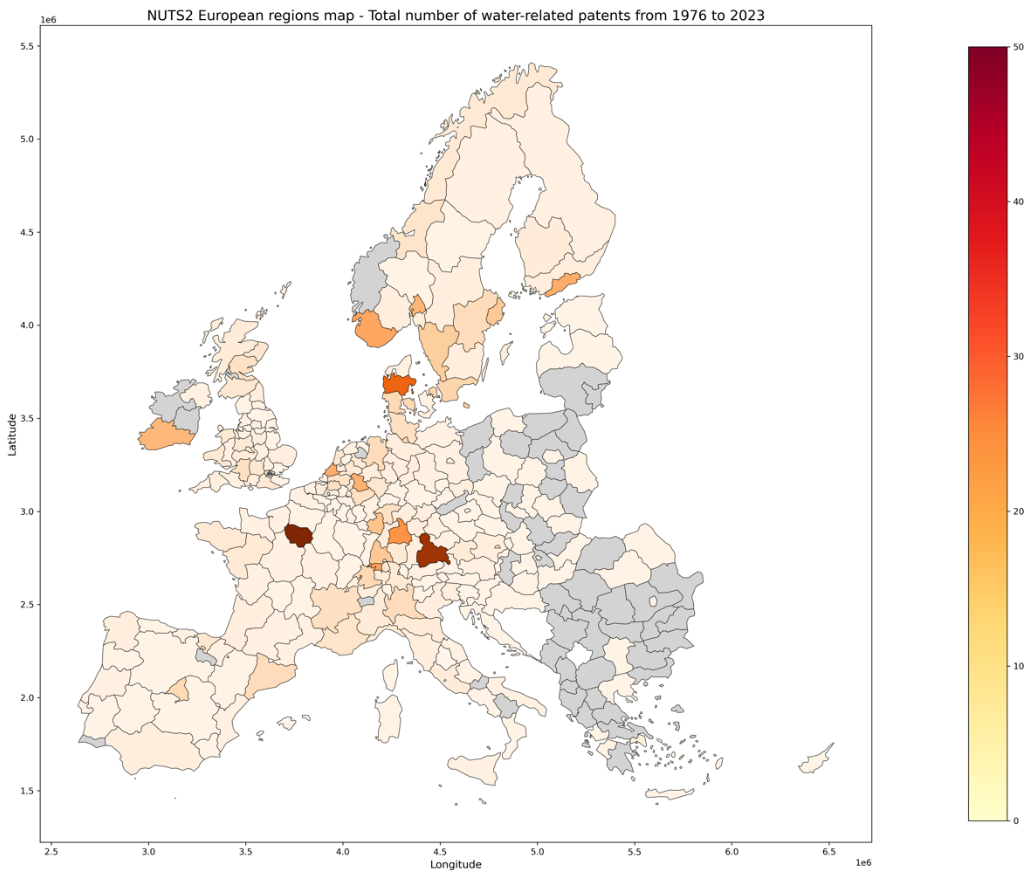


Fig 1: Total number of patents in European NUTS2 regions in water-related technologies from 1976-2023.

Key Variables

In this report, we will proxy innovation output as the number of total patents filled in a given period of time t in a specific technology f, belonging to one of the water-related technologies.

To analyse the likelihood of each region producing green patents, we will use different metrics to proxy the extreme weather conditions. First, we will use the total losses of millions of Euros. Secondly, we will use the number of people affected and the number of fatalities per extreme weather event. Finally, we will also consider the total number of events per se.

Data Summary: Descriptive stats and visualisation

Table 1 below shows the main descriptive statistics of the variables used in this study.

Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
pat	935	10.725	27.5	0	328
pat_d	935	.72	.449	0	1
event	1554	1.735	3.059	0	28
log_losses	1554	2.495	3.329	0	10.997
personsaff~d	1554	123.427	391.813	0	5053.22
fatalities	1554	13.552	65.79	0	1566
gdp	1180	4.33e+07	7.26e+08	710.529	1.65e+10
population	1182	1920000	1560000	113000	1.23e+07
pop_dens	1182	286.669	628.814	2.09	7539.688

Table 1: summary of variables.

In Table 1 we can see the main descriptive statistics of the variables. Note that the variable pat is the count variable for the total number of regions and periods and the number of patents developed in total in a region at a certain time; we can see that the maximum number reflected is 328 for only one period. This means that a region has 328 patents in one period, corresponding to Ille de France, the region with the most filled patents. Aggregated, the second most popular producer of patents is Munich, and Mid Jutland follows it in Denmark. The two first regions on the podium are expected to be the main drivers of innovation in Europe when analysing the total number of patents in any technology at the NUTS2 level. Surprisingly, though, it is third place for Mid Jutland, and this could be driven by the big wind turbine industry offshore.

The variable of interest here is pat_d, which is the dummy variable of pat, and it takes a value of 1 or 0 depending on the presence of any water-related technology patent in a given region/time. Observing the other variables reflecting the events, we see that a region in a certain period had a maximum of 28 flood events, and the mean for each region in each period is 1,735 events per region/time all over the sample.

Figures 2 to 4 show the trend of event occurrence with the number of losses in millions of Euros, the number of killed people and the number of people affected. As can be seen, climate events in Figure 5 show a steady increase since the 90s, likely due to climate change, but also more economic growth, steady population growth and great urbanisation. On the other hand, the number of fatalities decreased, probably due to the management and preparedness of regions for extreme weather conditions and more resources to face these situations, as displayed in Figure 4.

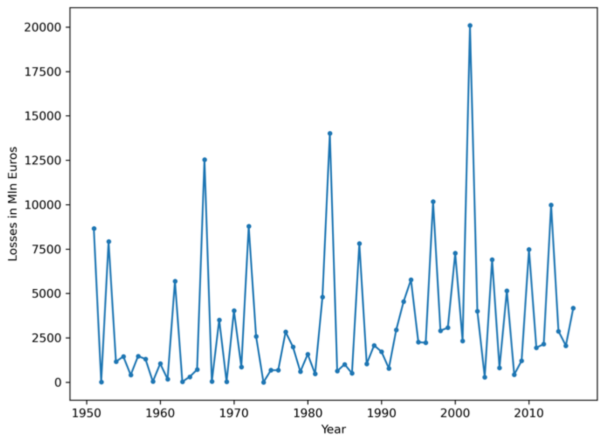


Fig.2: Million of Euros lost due to floods in Europe over time.

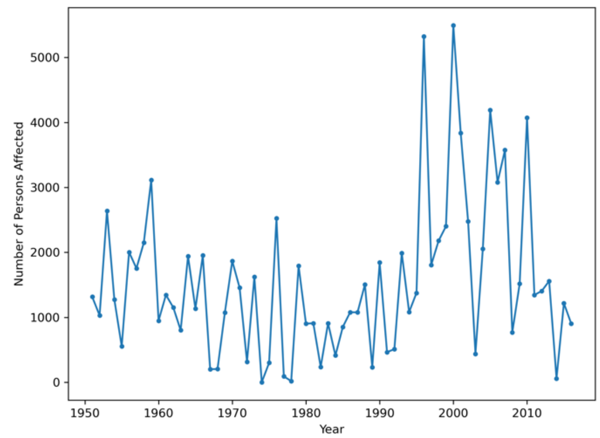


Fig. 3: N. of affected people over time.

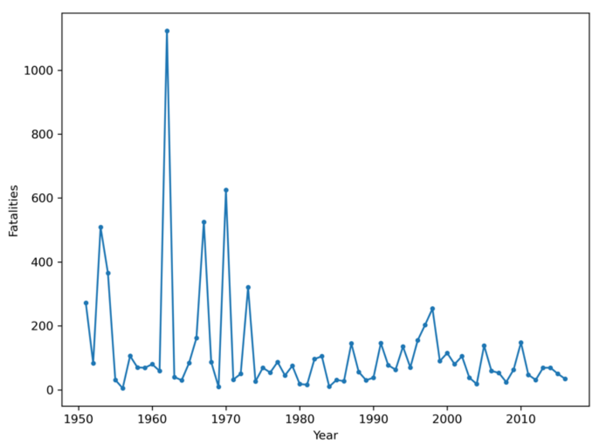


Fig. 4: N. of Fatalities over time. Source: own elaboration.

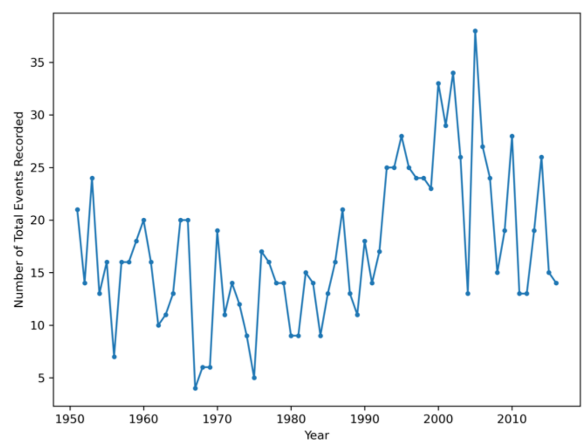


Fig. 5: N. of Total Event over time. Source: own elaboration.

Figures 2 – 5: Source Hazard dataset, own elaboration.

Regarding the patents in water-related technologies, Figure 6 plots the top 10 most technology classes of patents submitted in Europe. As in the case of the Netherlands, most technologies are related to wind turbines offshore and the mounting and assembly of those technologies on the sea. We also see the development of other fishing, aquaculture and aquafarming technologies.

However, the biggest share of technological development at the continental level is the production of energy from the sea waves, with more than 10% of the share of patented technologies.

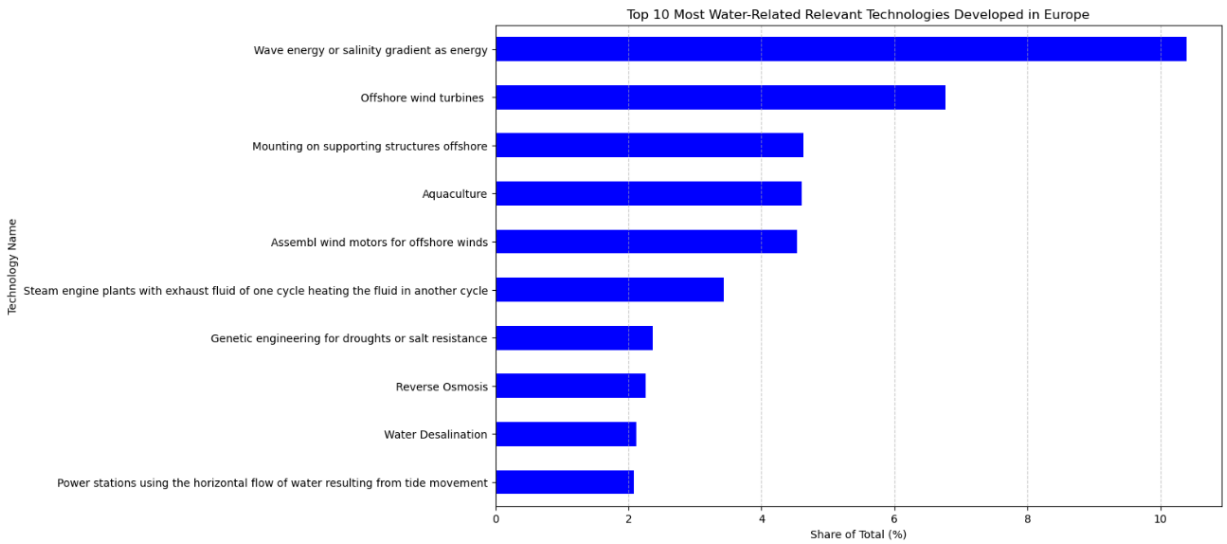


Fig. 6: Top technological patents submitted in Europe.

Methodology:

We tested our hypothesis using a simple regression analysis to see the likelihood of the region inventing new green water-related technologies due to past extreme weather events concerning rainfalls and floodings.

To do so, we employed a Linear Probability Model to test the relationship between the weather events (in all its forms of measurements) and the likelihood of regions developing green water-related technologies. To do so, we transformed our main dependent variable -the number of patents each region has in green water-related technologies. We created a binary variable that captures whether a region has produced at least one of these patents (value 1) or none (value 0). By transforming this variable, we take into account that patent activities are heavily concentrated in innovative regions. With this transformation, we avoid observations of regions with a high concentration of patents and regions with only one patent, and we assign a 1 to those regions with at least one patent in the field of water-related technologies.

We also tried different regressors to see the individual effect of the total losses in Euros, the number of persons affected, the number of fatalities and the total number of events. We hypothesise that, indeed, it is not only per se the number of events that makes regions develop new technologies to mitigate weather calamities but also the intensity of the events measured by the material losses, the number of fatalities and the number of people affected as well.

To identify the path dependency, we shifted one period of the independent variables compared to the dependent variable. Shifting one period on our calamities dataset helps us predict the likelihood of patenting activities related to weather events in the past in that same region. We followed 1 period of around 9 years of lag following the seminal work on the relationship between climate change and economic growth by Dell et al. (2008). They ran a panel regression with up to 10 years of lag to explain the economic output years after the meteorological events, in their case, the rise of temperature. Consequently, period t-1 (between 1969 and 1978) of the extreme weather events will explain the likelihood of regions patenting between 1978 and 1986. In our Regpat dataset, 1978 was the first year we observed a European region patenting one of the green water-related technologies. As we have 44 years of records on patent activities, we will aggregate our data in 5 periods of roughly 9 years each. Regarding the independent variables, we used the Hazard dataset with entries from 9 years before the first patent recorded in Europe and until the last recorded event in 2016.

Analysis and Findings

We conducted a single model, adding all the independent variables of interests individually and then combining them. The results show that our estimation only has a statistically significant effect when we run the model for the frequency of events and the likelihood of producing green patents, and when we add all the variables altogether.

Our first finding suggests a positive and significant effect of the number of extreme weather events on the likelihood of producing water-related technologies. This implies that a higher frequency of weather events alone influences the path dependency of regions to produce green patents. The model shows that regions having an event will likely have a 1,5 % probability of having a green patent in water-related technologies compared to regions that have never experienced extreme weather events. This also holds when we add all the variables to the model.

The same scenario can be derived when we correlate the lagged version of the losses in million of Euros on the likelihood of patenting. In this case, a positive albeit insignificant relationship exists between millions of Euros lost in each weather event and the likelihood of regions producing green patents in water-related technologies.

When examining the impact of extreme weather events measured by the number of people affected and fatalities, the model does not significantly affect the likelihood of these regions producing green water-related technologies.

Lastly, we examined the interaction effect of the total number of events and the total financial losses in millions of euros on the likelihood of regions producing more green water-related inventions. Here, we found a significant but negative effect. This might indicate that both the financial losses from extreme weather events and the frequency of such events are determinants of the likelihood of regions producing green patents related to water technologies, but negatively. In sum, having had extreme weather events and having material losses decreased the likelihood of regions producing green patents in water-related technologies. Yet, it is worth noting that the effect is marginal, at only 0,0002%. This would indicate that there is indeed a negative and significant effect, but the margin of this effect is almost irrelevant.

More strikingly, the model revealed that the individual effect of having an event and the millions of Euros lost due to extreme weather events have a positive and significant effect on the probability that a region develops a green patent in one of the water-related technologies described at the very beginning. The results here are significant and robust as we also control for other confounding measurements of extreme weather events and the general controls and fixed effects added to all our models.

As a robustness check, we also ran the same models but considering only the water-related technologies strictly related to floods, such as water collection from rain events, the construction of dikes and dams, and aquaculture. In these models, we could verify our main hypothesis that events per se impact the patenting activities in regions mainly affected by natural disasters related to flooding, but not quite by the millions of Euros they lost. However, when we plot the model and include all the variables, the number of events and the Euros lost due to a calamity are positively and significantly related to the likelihood of regions inventing more patents. Yet, the interaction effect between the number of events and the Euros lost in each event yields a negative and significant effect.

Finally, we can also see that for the individual effect of the variables people affected and fatalities, we see a negative effect, although not statistically significant. The negative sign can be attributed to modern resilience in protecting lives despite material losses, as illustrated in Figures 3 and 4. Regions have increasingly focused on minimising fatalities and people affected over time, and the relationship between these variables and the innovation output of each region is negative. All these results can be checked in Table 1 in Annex B.

Not all water-related technologies are necessarily linked to flood events in a given region. Unfortunately, the available data only provides insight into the disasters caused by extreme rainfall, snowmelt, or river flooding in the observed regions. We lack information on natural disasters related to heavy sea storms, sea pollution, or other events beyond heavy rain and flooding. Therefore, we decided to analyse patenting activities for technologies intrinsically related to flood events. These technologies include, but are not limited to, innovations in dams, dikes, water management, aquaculture, water purification, and rainwater collection. Figure 7 shows the top 10 technologies associated with flood events based on this restricted sample.

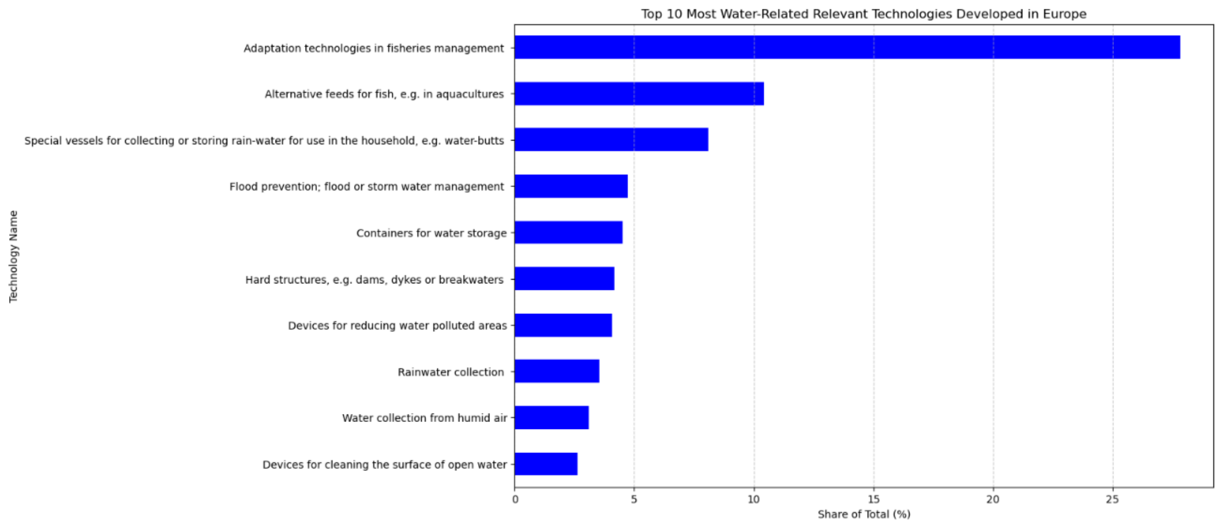


Figure 7: Top 10 technologies produced in Europe in restricted water-related technologies. Source: Own elaboration with Regpat data.

Another interesting insight from this sample restriction is that the most prominent and prolific regions in patent activities change drastically in the case of flood-related technologies. Indeed, since aquaculture technologies have predominance, we can observe that regions in Norway are dynamic and important, although scattered around different cities. This is also the case for Dutch regions, represented in the top 20 of NUTS 2 regions patenting on flood-related technologies, albeit scattered around different Dutch cities. This can be because regions in the Netherlands are developing technologies related to hard structures, dams or dikes. On the contrary, we can see NUTS2 regions that are in the top 10 and also cities that are the stars in the application of patents, such as Paris and Munich[4].

The two top applicants in Europe are two Dutch companies, one based in North Holland and the other one in Limburg, and this is something that can be appreciated in the top 10 cities where the patent activities occur in Figure 9[5].

[4] London, for instance, is always a star in the geography of innovation concentration. Still, since statistically, it is divided into four different NUTS2 regions, it never appears as a top-region applicant but as an active city.

[5] Note that, in some NUTS2 regions, statistical regions, we can find many cities developing patents within that same region. This is case of NL41 (North Brabant) with patents from the city of Boxmeer (explained by the top 10th applicant, the Dutch pharmaceutical Intervet International) and Eindhoven.

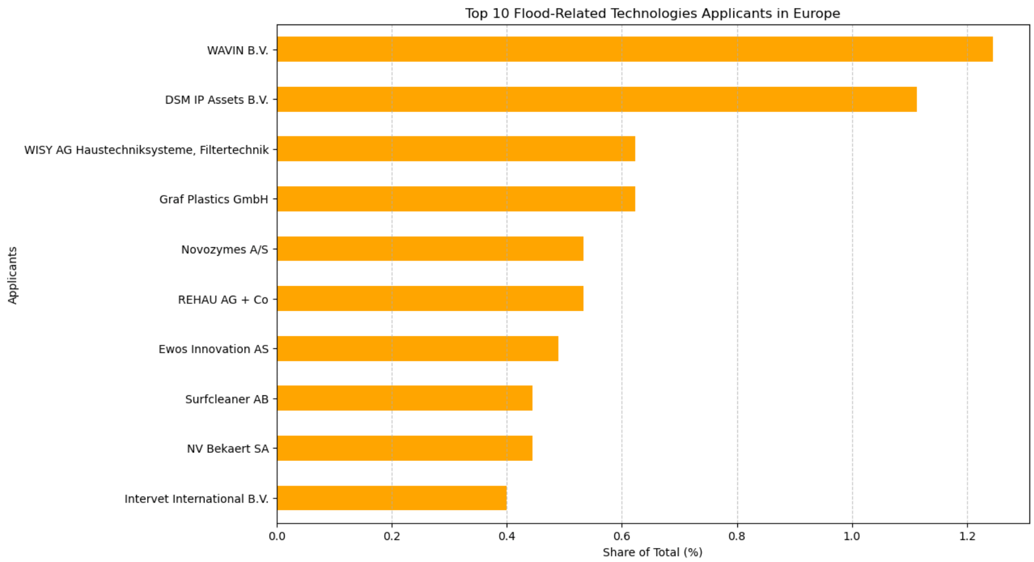


Figure 8: Top 10 European applicants in restricted water-related technologies from 1976 to 2023. Source: Own elaboration with Regpat data.

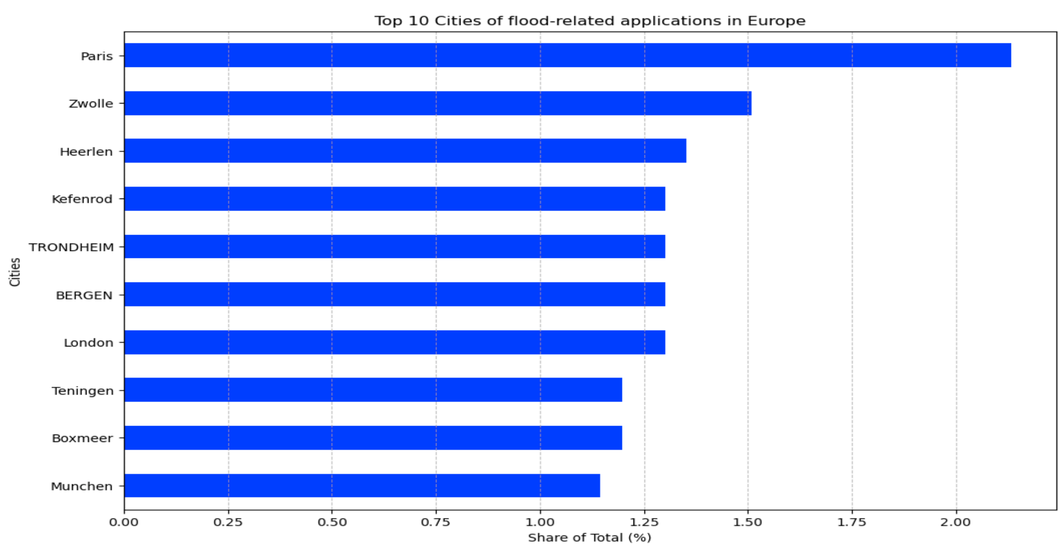


Figure 9: Top 10 European cities that are top restricted water-related technologies applicants. Source: Own elaboration with Regpat data.

With this refined approach, we focused on technologies related explicitly to floods, aiming to understand better the connection between flood events and the development of water-related technologies.

We conducted a new regression analysis using this restricted sample, and the findings confirm that each flood event influences the likelihood of regions producing such technologies. However, the analysis does not show a clear impact of economic losses -in terms of millions of Euros lost-, people affected, or casualties on this likelihood. Interestingly, when we include all variables in the full model, flood events and the economic losses in millions of Euros significantly and positively affect regional patent activities. Conversely, the interaction between losses and events significantly impacts the likelihood of producing flooded-related technologies. This suggests a complex relationship where the severity of losses may dampen innovation, even as the events themselves drive technological development.

Conclusion

In this report, we aimed to determine whether there is a link between the path dependency of regions that have experienced climate-related calamities, specifically floods, and the innovation in water-related technologies.

We introduced the path dependency theory, asserting that past events shape a region's innovation output. Path dependency involves the continuity of regional behavior patterns influenced by historical climate conditions and internal factors like capabilities and institutions. We argue that these external climate conditions impact the landscape and stakeholder decisions in the region.

We also presented our dataset, including descriptive statistics to identify weather calamity patterns over the years, the distribution of technologies across Europe, and significant technological developments. Our analysis suggests that extreme weather events significantly influence the likelihood of regions developing water-related green technologies, as indicated by a 1,5% increase in such patents for each additional event experienced by a region. This relationship holds even when accounting for other variables, with the effect magnitude increasing to 2,2%. However, financial losses, the number of people affected, and fatalities from these events do not significantly influence green technology development, suggesting that modern resilience measures might mitigate these impacts.

Interestingly, the interaction between the frequency of events and financial losses shows a significant but marginally negative effect on innovation. This implies that while these factors are important, they alone are not sufficient to drive technological advancements. Other variables such as skills, capabilities, institutions, and R&D investments also play crucial roles.

Our analysis underscores the complex dynamics at play. While extreme weather events seem to drive innovation per se, material losses, or the number of people affected and killed do not suffice to spur technological advancements.

Furthermore, regions that have faced more frequent events in the past have benefited from these calamities by spurring innovation in green water-related technologies. This can be attributed to their level of preparedness and resilience, leading to new technological advancements designed to overcome these events. Evidently, the frequency of these events plays a more crucial role in driving innovation than their magnitude.

For policymakers, this analysis can be useful for considering policies related to flood events affecting their regions:

- **Encouraging Innovation**: Policymakers should focus on regions experiencing frequent extreme weather events as potential hubs for developing water-related green technologies, provided there are adequate institutional and skill capabilities.
- **Resilience Investments**: Investing in resilience and protective measures can help mitigate the negative impacts of extreme weather events, thus supporting continuous innovation even in the face of disasters. This includes investing in infrastructure and adaptive technologies that protect lives and property.
- **Targeted Funding**: Financial incentives and support should be targeted toward regions with a history of extreme weather events to maximize the region's resilience and its potential for green innovation.

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Annex 1: Identification Strategy

In our identification strategy, we proposed 5 different approaches to test the path dependency, including the relationship between losses in Euros, people affected and fatalities, the innovative output of each region, and then the relationship between the total number of events and the innovative output of each region (patents in water-related technologies). Finally, we included an interaction term capturing the total number of events and the total losses in million of Euros. This interaction aims at capturing the joint effect of the material losses and the frequency of the weather events altogether on the probability of regions producing patents in green water-related technologies

The identification strategies, mathematically, will be:

$$Y_{rt} = \beta_0 + \beta_1 Losses_{rt-1} + \chi_{rt-1} + \delta_r + \gamma_t \text{ (1)}$$

$$Y_{rt} = \beta_0 + \beta_1 Fatalities_{rt-1} + \chi_{rt-1} + \delta_r + \gamma_t \text{ (2)}$$

$$Y_{rt} = \beta_0 + \beta_1 People\_aff_{rt-1} + \chi_{rt-1} + \delta_r + \gamma_t \text{ (3)}$$

$$Y_{rt} = \beta_0 + \beta_1 Events_{rt-1} + \chi_{rt-1} + \delta_r + \gamma_t \text{ (4)}$$

$$Y_{rt} = \beta_0 + \beta_1 Losses_{rt-1} + \beta_2 Events_{rt-1} + \beta_3 Losses_{rt-1} * Events_{rt-1} + \chi_{rt-1} + \delta_r + \gamma_t$$

(5)

Where Y_{rt} are the total number of water-related patents in region r and time t. $Losses_{rt-1}$ refers to the coefficient of patents created by every million of Euros lost due to an extreme weather disaster in region r and time t-1; $Fatalities_{rt-1}$ refers to the coefficient of patents created followed the loss of one human life due to an extreme weather disaster in region r and time t-1; and $People\_aff_{rt-1}$ refers to the coefficient of patents created by every person affected due to an extreme weather disaster in region r and time t-1.

$Events_{rt-1}$ refers to the coefficient of patents created every time there was an extreme weather disaster recorded in region r and time t-1. Moreover, the coefficient $Losses_{rt-1} * Events_{rt-1}$ will indicate the combined effect of the material losses and the number of events on the likelihood of regions filling more patents in region r and time t-1.

χ_{rt-1} is a vector of control variables such as the area in square km, population density, total GDP, total number of general patents (any technology) and total population in each region r in time t-1.

Finally, δ_r and γ_t are region and time-fixed effects, respectively.

In our regression, we used a binary Dependent variable that takes the value 1 if there is at least 1 patent in green water-related technology at time t in region r and 0 otherwise. We regressed it with the other variables that capture the different measures of the extreme weather events. In our estimations, we also added a bunch of control variables to account for other features that might be related to the general production of green water-related patents (such as the level of GDP or population density). Finally, we added region and time-fixed effects to control for any unobservable characteristic that affected each region and time in our model.

Annex 2: Regression tables.

Table 1: Linear Probability Model on the likelihood of Regions producing at least one water-related technologies as a function of the total number of flooding weather events, its material losses, the fatalities and the person affected

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Patents	Patents	Patents	Patents	Patents
event = L,	0.015***				0.022***
	(0.001)				(0.000)
losses = L,		0.000			0.0003*
		(0.476)			(0.078)
cL.event#cL.losses					-0.000002*
					(0.089)
Fatalities = L,				0.000	-0.000
				(0.851)	(0.722)
Persons affected = L,			0.000		-0.000
			(0.326)		(0.277)
Constant	-2.436***	-2.917***	-2.832***	-2.919***	-2.549***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	708	708	708	708	708
R-squared	0.378	0.370	0.370	0.369	0.383
Period FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES

Robust pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Linear Probability Model on the likelihood of Regions producing at least one water-related technologies as a function of the total number of flooding weather events, its material losses the fatalities, and the person affected

Table 2: Linear Probability Model on the likelihood of Regions producing at least one flood-related technologies as a function of the total number of flooding weather events, its material losses, the fatalities and the person affected

VARIABLES	(1) Patents	(2) Patents	(3) Patents	(4) Patents	(5) Patents
event = L,	0.008				0.016**
	(0.191)				(0.024)
losses = L,		0.000			0.000**
		(0.615)			(0.014)
cL.event#cL.losses					-0.000***
					(0.005)
Fatalities = L,				-0.000	-0.000
				(0.767)	(0.469)
Persons affected = L,			0.000		-0.000
			(0.649)		(0.519)
Constant	-2.677**	-2.993***	-2.929***	-3.040***	-2.955***
	(0.013)	(0.004)	(0.006)	(0.004)	(0.007)
Observations	612	612	612	612	612
R-squared	0.312	0.310	0.310	0.310	0.320
Period FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES

Robust pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Linear Probability Model on the likelihood of Regions producing at least one flood-related technology as a function of the total number of flooding weather events, its material losses, the fatalities, and the person affected.