

# Are Flooding Defence Policies Effective? Response from Housing Price in London.

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## **I. Introduction & Literature Review**

In England surface water flooding is the most common flood risk, with more than 62% of properties are at such flood risk (HM Treasury, 2021). Every year surface water flooding is estimated to cause £1.3-£2.2 bn of damages to properties (Jenkin et al., 2017). Surface water flooding, also referred as urban flooding or pluvial flooding, is a type of flood that is characterised by short duration with high intensity. It occurs when there is excess volume of water on the ground surface causing by heavy rainfall (Jenkins et.al, 2018). Large volume of rainwater hits the ground at high speed but unable to permeate the concrete floor in urban areas and accumulate in area with low elevation. Drainage system can convey away surface water but excessive water on ground surface can overload the drainage system capacity causing surface water flooding. As a result, surface water flooding risk is significant in area with heavy urbanisation such as London due to its dense population and reduced urban ground permeability putting London's aging drainage system under pressure.

### **England and Wales Policy Context**

Climate change is evident to have the potential to increase the frequency and intensity of heavy rainfall, posing great threat to infrastructures and properties in urban areas (Rubinato et al. 2019). The UK Government has transferred responsibility for the management of flood risk to local actors following the enactment of Localism Act 2011 decentralising implementation of flood resilience measures to local councils and relevant bodies which makes the capacity to deliver flood risk management depends on the resources available of the local councils (Begg et al., 2015; Snow et al., 2020).

Current flood risk management approaches are, firstly, in the form of regulations and policies, secondly, insurance scheme named Flood Re (Jenkins et al., 2017).

Taking London as an example, given its dense population, high level of urbanisation and aging infrastructures, the main course of action to mitigate the flood risk is to pervious surfaces, upgrade drainage system and improve property protection measures (Jenkins et al., 2017). On 12 July 2021 and 25 July 2021, London experienced intense rainstorms overwhelmed London drainage system 24 boroughs were affected, impacting east and north London the most (Gilby, 2022). Mayor of London together with the Environment Agency to explore long term solutions to surface water risk following the incidents (HM Treasury, 2021). The National Infrastructure Commission (NIC) has been asked to conduct study to investigate improvements required to mitigate surface water flooding in the UK (NIC, 2021). Thames Estuary 2100 also came into stage in 2012 putting forward a flood risk management

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action plan to give recommendations to local councils and relevant bodies to keep up with climate change. Two of the areas of concern are West London (Richmond, Twickenham, Barnes and Kew and Hammersmith) and Central London (from Wandsworth to Deptford), both of which are of high potential of pluvial and urban flooding risk (Agency E, 2012). West London, including borough of Hammersmith, Kensington and Chelsea are densely populated and urban drainage systems are dated and of low capacity. Many important sites and city service infrastructures such as Battersea Power Station, Albert Embankments and underground and railway stations, locate along the river side which are very vulnerable to surface water flooding. In addition, there are large area of low-lying grounds along the riverside making surface water difficult to be drained.

Local councils receive annual grant from central government (Jenkins et al., 2017). On top of annual grant, Royal Borough of Kensington and Chelsea requires major development to increase greenfield run-off rate by enhancing ground permeability and fitting new sustainable drainage system to the development. In addition to installing new drainage system, Central London such as London Borough of Lambeth imposed legal obligation on Transport of London to maintain effective drainage of surface water from adopted roads and local residents to protect their home from flooding such as depraving front garden (URS, 2018).

Local Councils also have the rights to impose Community Infrastructure Levy (CIL) on developers as a condition to planning permission funding long term flood alleviation and regeneration the local area (BNP Paribas real estate, 2019).

Regarding Flood Re, government enforced policy agreement with private insurance company to reinforce minimum insurance protection against flood risk (Penning-Roswell et. al, 2014). From 2013 flood risk insurance has been made affordable and remained available to all private homeowners. Nevertheless, the level of flood risk is a dominate factor in deciding the premium and availability in areas of high flooding risk (Lamond et al., 2009, Jenkins et al., 2017). Findings of a study using an agent-based model, combining insurance and sustainable drainage system scheme is to be effective in reducing flood risk (Jenkins et al., 2017).

## **Objectives and aims**

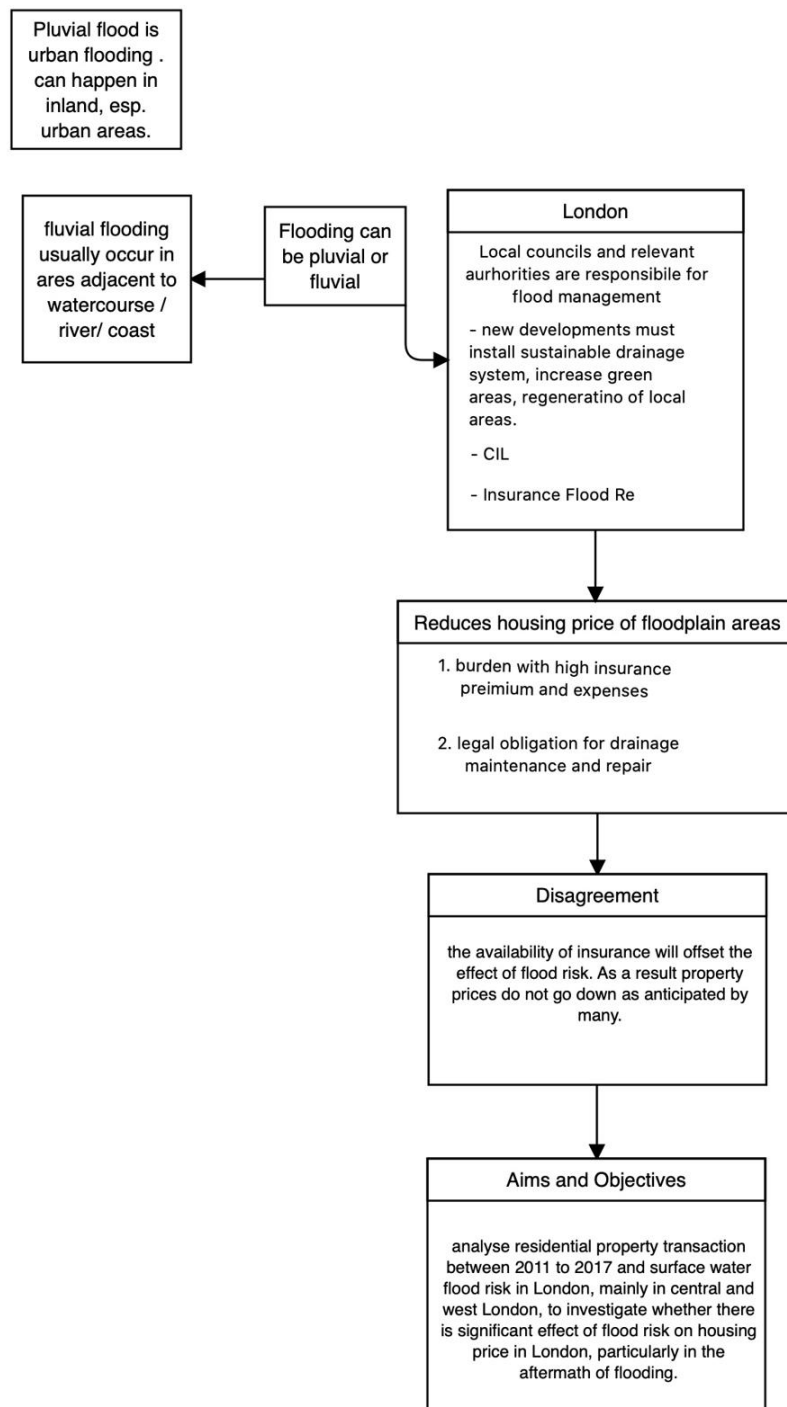
Surface water flooding has great socio-economic impacts (Zhou et.al, 2019). In fact, many studies found that flood risk is a significant factor that influence housing price negatively (Bekes et al., 2016; Stakhiv et al., 1998; Miller & Pinter, 2022). Given the above, it is reasonable to surmise that flood risk has a more than minimal effect on housing price in London because homeowners or buyers of properties located in high flood risk areas are likely to be burdened with high insurance premium, expenses and legal obligations; thus reduces market housing price of properties located on floodplain.

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It was also suggested that housing market price drops the most immediately after flood incidence and will recover after repair when buyers have less bargaining power (Belanger & Bourdeau-Brien, 2018; Pyce et al., 2011). However, it was also suggested flood insurance can reduce the risk of flooding and perceived risk rendering homebuyers more willing to purchase properties with high flood risk (Jenkins et al., 2017; Cheung & Yiu, 2022).

Reflecting from emerging evidence from various countries, this study will analyse residential property transaction between 2011 to 2017 and surface water flood risk in London, mainly in central and west London, to test whether there is significant effect of flood risk on housing price in London, particularly after flooding incidents.

## 1.1 Research Question & Mindmap



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## II. Data & Methodologies

Data used in this piece of work varies from London House Price Index to Historic Flood Map, obtained from GOV.UK. Inspired by previous works done by researchers from different countries, this paper aims to study the effectiveness of flooding policies and its result reflected on house price.

The reason house price was chosen as a public confidence reflection of flooding risk improvement is the long-term character of real estate investment. People are often more conscious when it comes to real estate investment, and they tend to be risk averse. Their research is usually more comprehensive and detailed before their purchase and investment, comparing to commodity and cryptocurrency investment.

This study will visualize the house price before and after policy implementation or announcement. Due to the uncertainty brought by BREXIT and COVID-19, study period was set to 2017-2019, where house price is comparatively stable – linear upward trend.

### 2.1 Data Collection

#### All-time observation

##### House Price Index

Obtained from London Datastore where the original data provider is Land Registry.

The raw dataset includes a few variables about UK housing market, monthly released.

##### Variables:

- House Price by Type
- Average Price
- Index Price
- Sales Volume

Period of observations: Jan-1995 --> Sep-2021

Frequency: Monthly

Description: “The UK House Price Index (UK HPI) captures changes in the value of residential properties and uses sales data collected on residential housing transactions, whether for cash or with a mortgage.”

Smallest Geometry: Borough level

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## **Before Policies – 2011**

### **Flood Risk of Surface Water Flooding (Urban Flooding)**

Obtained from London Datastore where the original data provider is Environment Agency.

The raw dataset includes percentage of area at risk of urban/fluvial flood. Original data collection used national datasets on exposure to flooding, Environment Agency data, and exposure to heat, from UKCP09 data.

#### **Variables:**

- Percentage of area at moderate and significant risk of fluvial flooding
- Percentage of area at risk of surface water flooding (1 in 30 years)
- Percentage of area at risk of surface water flooding (1 in 100 years)
- Percentage of area at risk of surface water flooding (1 in 1000 years)

**Period** of observations: 2011

**File Type:** .xlsx (cleaned and transformed to individual CSVs)

**Smallest Geometry:** Middle Super Output Area - MSOA

### **Flood Disadvantage Index of Surface Water Flooding (Urban Flooding)**

Obtained from London Datastore where the original data provider is Environment Agency.

The raw dataset keeps record of pluvial flood disadvantage index with various scale. Initial data collection handled by Environmental Agency, together with “**Flood Risk of Surface Water Flooding (Urban Flooding)**”.

#### **Variables:**

- Percentage of area at moderate and significant risk of fluvial flooding
- Pluvial flood disadvantage index (1 in 30 years)
- Pluvial flood disadvantage index (1 in 100 years)
- Pluvial flood disadvantage index (1 in 1000 years)

**Period** of observations: 2011

**File Type:** .xlsx (cleaned and transformed to individual CSVs)

**Smallest Geometry:** Middle Super Output Area – MSOA



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## **After Policies – 2017**

### **Flood Risk Zone of Surface Water Flooding (Urban Flooding)**

Obtained from London Datastore where the original data provider is Environment Agency.

The raw dataset keeps record of pluvial flood disadvantage index with various scale. Initial data collection handled by Environmental Agency, Flood Risk Zones.

Period of observations: 2017

File Type: .shp

Smallest Geometry: Middle Super Output Area – MSOA

## **2.2 Data Cleaning and Processing**

Datasets obtained without standardized geographic information. Firstly, remove Nan observations which affects the quality of visualization, by row. Secondly, join each of the three datasets below with London Geographic Boundaries (Borough and MSOA level) for mapping later, reproject all Coordinate Reference System to EPSG27700 which is the suitable format for Greater London area. Finally add/mutate count of flooding in certain area (MSOA/Borough level, depending on compatibility), for clarity and comparison.

Following datasets were processed:

House Price Index

Flood Risk of Surface Water Flooding (Urban Flooding)

Flood Disadvantage Index of Surface Water Flooding (Urban Flooding)

## **2.3 Method Justification**

As introduced in literature review, the focus of this study falls in certain areas: Kensington and Chelsea, Wandsworth and briefly on the other river-south regions. Kensington and Chelsea were chosen because of the severity of surface water flooding issue in this area, reflected by the data collected in 2011. However, due to the popularity of this borough, the housing price sensitivity is well stabilized at a low level, by its central location and capital flow centrality.

Wandsworth and river-south regions were chosen for the reason of rather the opposite housing market outlook, it is less popular than RBKC (Royal Borough of Kensington and Chelsea) so the stability

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and robustness of the housing price growth trend in this area is much lower and their housing price is more sensitive to local infrastructure improvement and evolution.

In terms of timeframe, 2011 to 2017 were picked on purpose. One year after 2011, a severe flood attacked whole United Kingdom and Belgium, government started to be even more serious about flooding issue and the implementation of a 100-year flooding defence plan (TE2100) issued in August 2011 accelerated since then. Regarding the choice of 2017, it is because of geopolitical uncertainties brought by BREXIT since 2017 and COVID-19 since 2019 until recent. To eliminate the potential externalities affecting London housing market, 2017 is a suitable year to be set as “after policies” benchmark.

## III. Results

### 3.1 Descriptive Statistics

#### House Price Index

Over 7 years, the housing price almost doubled in Brent and at least jumped 25 per cent in most of the boroughs that are study interest of this study. In general, the upward trend is not negligible. In 2011, the average London house price started at £331,210 and ended up at a level of £535,811 in 2017. On average, sales volume as the representation of market activity chosen, kept steady from 227.4 per month in 2011 to 242.4 per month in 2017. Another look into the index price, which is telling another story. After adjustment and consideration of inflation, the housing price is still going north but it is not that cheering as it looks when average housing price is considered alone.

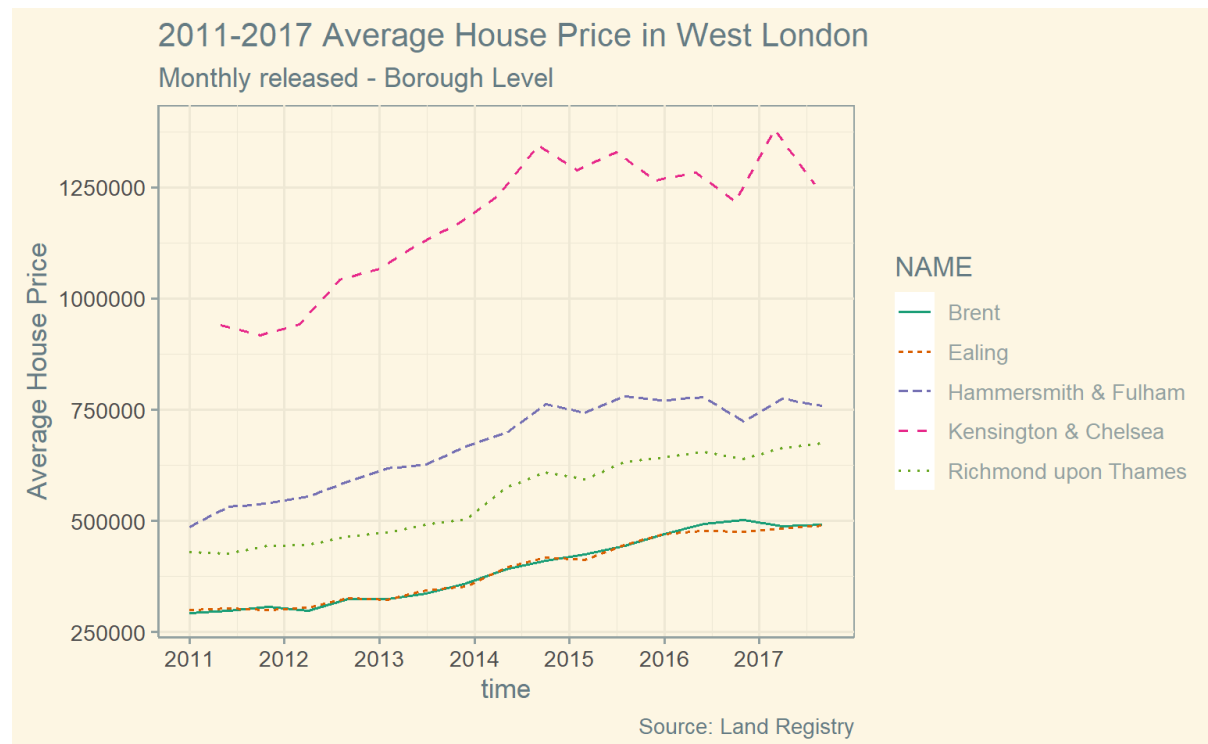


Figure 1. London Average House Price in West London – Borough level

There is no consolidated evidence to show price fluctuation in London Housing price has link to flooding events. In the event of 2012, 2014 and 2016 flooding events in London, there is no sign of correction from the borough level observation.

Major storms and floods in 2007, 2012, 2014, 2015- 16 and 2019- 2020, forcing tens of thousands of evacuations and causing billions of pounds worth of damage (BBC News, 2022). According to the major

flooding events, there is no sign in price drop in both West and South London, where my study interest lies. The corrections in 2015 and 2017 can be proven to be more linked with socio-economic change, monetary policy changes.

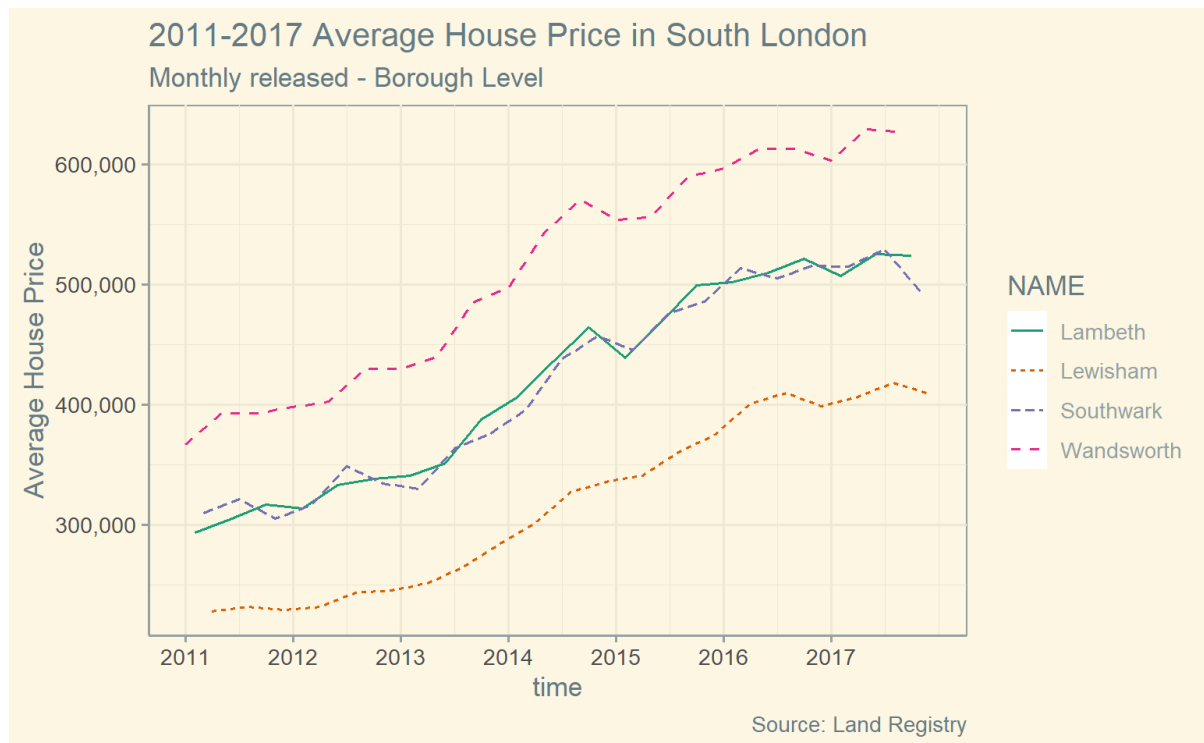


Figure 2. London Average House Price in West London – Borough level

### Flood Risk of Surface Water Flooding (Urban Flooding)

	Index score	Label
	$\geq 2.5$	Acute
	1.5 to 2.5	Extremely high
	0.5 to 1.5	Relatively high
	0.5 to -0.5	Average
	-0.5 to -1.5	Relatively low
	-1.5 to -2.5	Extremely low
	$\leq -2.5$	Slight

Figure. Flooding Risk Index Score Definition

Figure 3. Climate Just-Flood disadvantage\_2011\_Dec2014: Classification Scheme

“Surface water flood disadvantage score reflects socio-spatial vulnerability combined with score of percentage of MSOA unit covered by extents of flood zones associated with a 1 in 30-year; 1 in 100-year or 1 in 1000-year event.

Positive scores indicate increasing disadvantage. The scores are on a continuous scale but have been classified into categories for the purposes of mapping. The mapping categories are shown in the classifications tab.

(Note that the final scores are Z-scores which have been re-standardized following the equally weighted combination of flood hazard-exposure and flood socio-spatial vulnerability.

The disadvantage scores are influenced by extremely high flood hazard-exposure values. Socio-spatial vulnerability scores and the specific indicators from which they are generated must be considered alongside these results.

Z-scores have been used to standardized data according to the English mean. Final dataset excludes E02000001. The % area of a MSOA is not equivalent to the % of homes or people likely to be affected and is provided as a proxy of the potential to be affected.)”

- Source: Environment Agency (2012)

As a result, flooding risk itself did not change too much over time, geographically. The distribution and outlook of London Flooding Risk is consistent over 7 years. However, the flooding record itself is more informative. Flooding issue in south London, by record, has improved. It is reasonable to give the credit to policies imposed and distributed by central government. Each borough showed different approaches to the problem.

On the other hand, Kensington and Chelsea as one of the most well-planned boroughs in terms of fluvial flooding risk.

### 3.2 Visualization

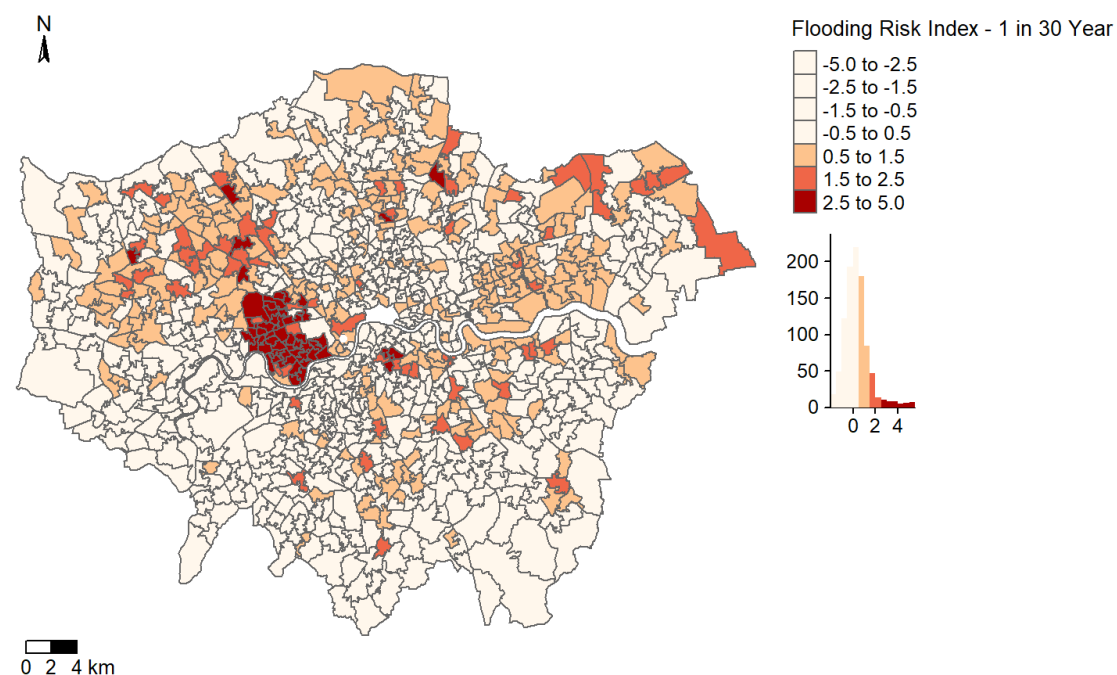


Figure 4. London Flooding Risk Index – Borough level – 1 in 30 Year Event

Over the time, flooding risk in many areas remained as a risk, meaning the lack of records of urban flooding in some high-risk areas. Improvement imposed by T2100 plan and effort put by borough councils has been effective, urban flooding in Kensington and Chelsea has been perfectly controlled. However, some of the boroughs in river-south have not had the same magnitude of improvement in terms of flooding risk management, i.e., Wandsworth. See figure 6, a comparison of flood record in different boroughs.



Figure 5. London Flooding Risk Index – Borough level – 1 in 100 (L) and 1 in 1000(R) Year Event

Data Source: Environment Agency



Figure 6. London Flooding Record – Borough level

Data Source: Environment Agency

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### 3.3 Awareness of the risk

The main argument this paper wishes to raise:

- The different characters of houses and buyers would affect more of their purchase decision, and accumulatively, the housing market.
- The access to flooding assessment information is asymmetric in the market.
- Which outweighs the other? Future risk or instant benefit?

First, the sensitivity to price of different buyer/investor types varies. Buyers of cheaper properties like council estate price at £500,000 are more sensitive to a £10,000 price difference whereas buyer/investor of 1,000,000 premium properties would not.

Second, the information asymmetry in housing market is not some news anymore. Premium house buyers tend to have more considerations and future risk assessment before they proceed to final payment.

Third, the risk aversion attitude of the different types of buyers can be very different. They may have very significantly different standards to future values and current benefit.

### 3.4 Limitation

This paper has discussed behavioral-economics perspective of property purchase decision, whereas the other papers and studies done in other countries has elaborated to evidence-based analysis on housing price alone. To cover both geopolitical and time-series illustration, certain level of depth in quantitative technique has been sacrificed.

## IV. Conclusion

First, characteristics and geographic features of properties matter, it overweighs the flooding risk in buyers' opinion in certain countries. Despite geographical difference, the rationality level varies from country to country. This reflects different levels of the awareness, to urban flooding risk.

Second, price sensitivity matters. It is one of the most important factors affecting the purchase/investment decision, in the opinion of this paper. It reflects how sensitive is the market to a reflection of flooding risk, in form of price. If the quick price change does not affect purchase decision, then the price will soon be insensitive to flooding-risk.

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Third, awareness of the risk and information asymmetry matter. According to the publication bias theorem, public information can be easily buried by positive characteristics of the property. End of the day, a flooding risk is not something more real to most property buyers when it comes to a viewing day.

However, the improvement of drainage infrastructure for flooding is highly appreciated and definitely reduced long-term risk for properties in London. It is just housing price in London may be driven by too many factors so that urban flooding risk is not necessarily affecting it effectively.



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## Appendix

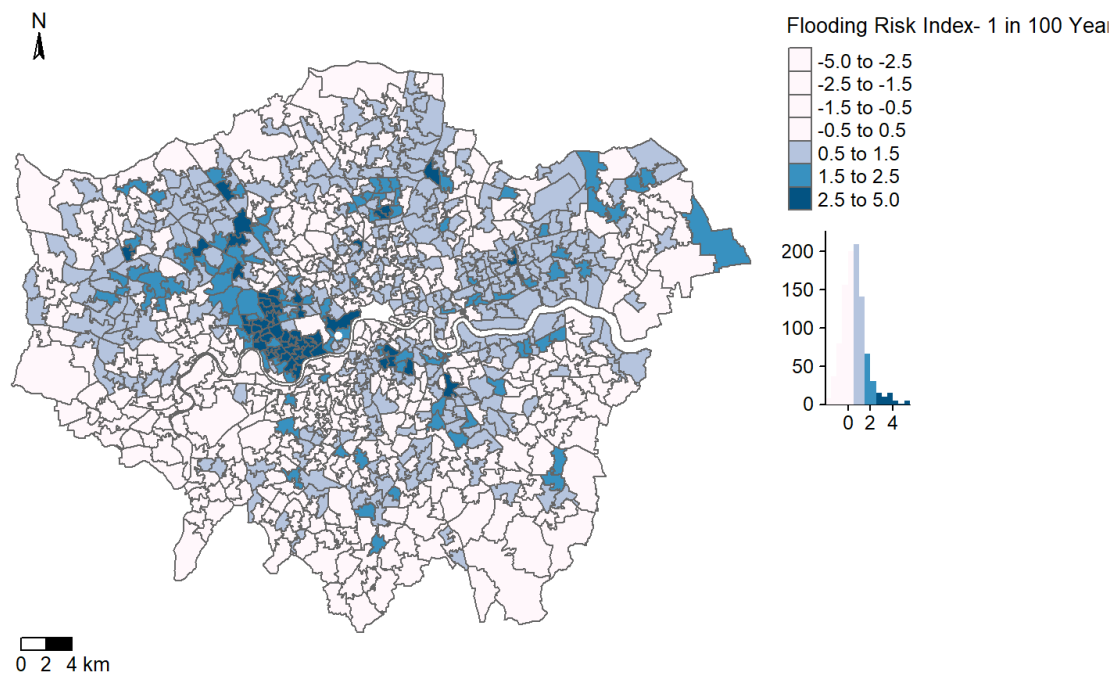


Figure 5 (L). London Flooding Risk Index – Borough level – 1 in 100 (L) and 1 in 1000(R) Year Event

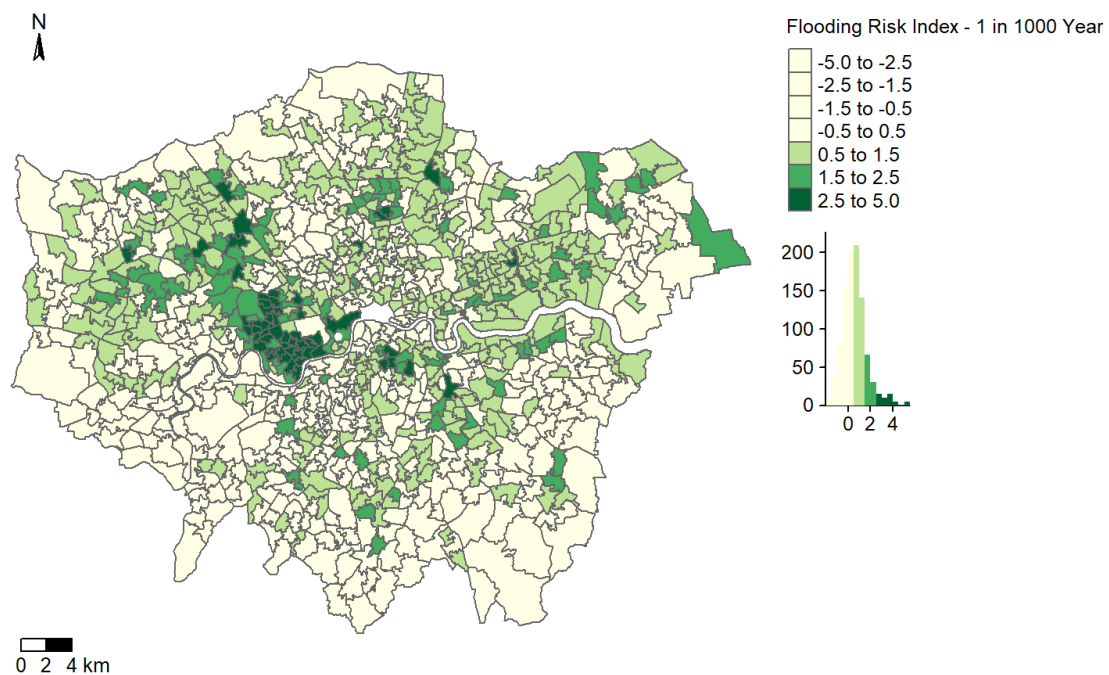


Figure 5 (R). London Flooding Risk Index – Borough level – 1 in 100 (L) and 1 in 1000(R) Year Event



Figure 6. London Flooding Record – Borough level

Data Source: Environment Agency