Modeling Household Preferences for Natural Hazard Insurance as an Indicator of Urban Resilience

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1. Introduction

Urban resilience is a slippery and relative concept. A disaster of a given magnitude may have very varying consequences across different individuals or communities. For example, in the case of flooding or earthquakes, even if the magnitude of damage borne by richer population groups is greater in absolute terms than that carried by the poor (more damage to property and wealth), the latter may still suffer greater relative damage due to their inability to cope with natural disasters. Traditionally the socio-economic resilience of a community relates to two features: the physical-capital material fabric of the community and its social composition. Physical-property resilience reflects wealth (capitalized in housing) and income. Loss of the wealth encapsulates the level of immediate exposure of the community and the distribution of income (pre and post event) is a potent indicator of the ability to rejuvenate. Social resilience is comprised of the aggregate characteristics of the population at risk. These denote the human composition of threatened communities.

Often these two dimensions are integrated to generate a composite index of resilience. This homogenization serves operational and policy interests. However, it also smoke-screens subtle distinctions between economic and social resilience. Despite the tendency to assume an association between the two, there does not need to be any a-priori correlation between them. For example, we can envisage a case of physically disabled people living in highly valuable but vulnerable sea-front residences or alternatively of highly skilled graduate students living in cheap accommodation in hazard-prone zones. This lack of correlation distorts measures of resilience.

A further dimension of resilience is often neglected. This paper suggests the existence of household insurance coverage as an under-recognized indicator. Household preference for insurance is an observed metric of revealed behavior. In this way, it bridges the gap between standard economic and social indicators. In this study we use statistical estimation, GIS tools and unique data on household insurance expenditure in Israel, to undertake a two-stage, demand-side analysis. In the first stage, we estimate variance in the spatial distribution of household insurance as a function of population socio-economic attributes, characteristics of the properties covered and distance from different hazard zones. In the second stage we assess the

relative weight of insurance resilience in an overall index of resilience, test its robustness and examine differences in resilience outcomes across different populations groups, locations and types of hazards.

2. Household Preference for Natural Hazard Insurance

Insurance is one of the most widely recognized risk reduction tools for the management of weather-related disaster such as floods, earthquakes, tsunamis, etc (Atreya et al., 2015). Insurance can be effective as a strategy for disaster risk reduction and as a mitigation tool when trying to adapt to climate change. Insurance allows individuals to cope with uncertainty by sharing financial risks across policy holders (Hudson et al., 2016).

Another way of viewing insurance is as a parameter for defining a 'resilient city', or a 'resilient society'. There is no single definition of a resilient city and many competing designations exist. Some regard urban resilience as the ability of a city to reorganize after a large-scale shock (Cruz at al., 2013). Others refer to the ability to 'bounce back' to its previous pre-disaster state (Campanella, 2008; Godschalk, 2003). Others still refer to a cities' ability to sustain a shock as an indication of urban durability (Alberti & Marzluff, 2004). Common to all these definitions is the notion of equilibrium urban growth with differences existing as to whether recovery is to a previous state, thereby assuming a single stable equilibrium (bouncing back) or to various recovery trajectories and multiple potential equilibria (bouncing forward) (Grinberger and Felsenstein, 2014). Irrespective of the definition chosen, insurance coverage intuitively has the potential to contribute to resilience by mediating the mechanistic tendencies of the equilibrium view. Through inserting a behavioral element into resilience, urban recovery becomes less predictable than the equilibrium view purports. The 'intentionality of human actions' (Davoudi, 2012, p. 305) as expressed by household preferences for insurance coverage implies that human intervention through choices, preferences and expectations is not effectively ignored in the resilience discourse.

The role of household preferences is effectively incorporated in determining resilience because insurance is a composite rather than unitary good. In purchasing insurance household reveal preferences with respect to their own assets, indirectly

articulate their expectations with respect to disasters and facilitate inference as to their perception of risk. The type of insurance coverage purchased is expected to reflect these choices: full or partial coverage, structure or content, mandatory or optional. In this respect, insurance coverage can be considered a prism for identifying different forms of household behavior when faced with uncertainty.

Insurance is not just a form of loss compensation but is also a key ingredient in risk mitigation and reduction (Kunreuther, 1998). Many government and institutions do not consider insurance as a natural hazard mitigation measure but insurance programs do have the potential to encourage loss reduction (Petak, 1998). In order for people to take protective action such as purchasing insurance it must be clear that they cannot rely on others to bail them out after a disaster as happened after many catastrophes in the USA when the government paid all costs of losses on the back of the taxpayer (Kunreuther, 1998).

2.1. The Demand for Natural Hazard Insurance: Empirical Evidence

While much evidence exists on the economic effect of hazard insurance on property values, less attention has been focused on the effect of insurance on household and community socio-economic resilience. In addition, much work has focused on flood insurance perhaps due to the high incidence of this hazard and the low rate of insurance coverage compared with fires or earthquakes. For example, the National Flood Insurance Program (NFIP) launched in the United States in 1968 to provide subsidized flood insurance to existing homeowners in exchange for the management of flood-prone area by local communities has attracted much attention (eg Shilling et al. 1989). But much of this emphasizes program impact on the housing market in areas eligible for the subsidized insurance.

Showers & Shotick (1994) analyze the impact of household characteristics on demand for total insurance. They find that changes in the household characteristics affect the demand. Increased income may create pressure on the family to purchase insurance. Multi-earner households are less likely to purchase insurance. As age of the household rises, so does the chance of purchasing insurance. However, as the household matures and the head of household ages, subsidized health insurance can substitute the need for general insurance. In addition, increasing household size is found to be positively related to expenditure on insurance.

Work by Blanchard-Boehm et al. (2001) investigate why some house owners in areas with a long history of flooding, choose to purchase flood-insurance while other do not. They find that the main factor determining an individual's propensity to purchase is the institutional requirements and their enforcement by mortgage lenders. Other significant variables incude (1) lender compliance; (2) perceptions of personal vulnerability to flooding relative to other hazards; (3) a concern that flooding will be a constant threat; (4) concern regarding government assistance during a major flood disaster. These factors become relevant when the purchase decision becomes voluntary for example, post-mortgage commitment or when a property is not located in an insurance-mandatory location. They suggest that forced insurance might create a "false sense of security" and a false perception that government assistance will become available in the event of a catastrophic event. Other studies also report complex interactions between psychological, economic and environmental factors affecting the household decision concerning hazard behavior (such as insurance purchase). In these instances they report that many people rely on their intuition. This study therefore challenges the intuitive notion that the demand for insurance coverage is directly related to socioeconomic status (Blanchard- Boehm et al., 2001).

Baumann and Sims (1978) observe the role of psychology and perception in the insurance decision from a different perspective. They report that people who share the same awareness of a hazard still behave differently. Most people who live in hazard zones are aware of the risk but this awareness does not necessarily lead to rational adaptive behavior such as insurance coverage. They outline the psychological variables that impact on the adoption or non-adoption of (flood) insurance. One dominant factor is defense against anxiety used by people to exclude themselves from the impact of a hazard. Another is behaving as if there is little to be done to reduce the damage of a disaster. A person confident of his ability to determine the future is more likely to purchase insurance than those who believe their future is controlled by outside forces. A further influence is a psycho-dynamic trait known as the "internal-external locus of control", i.e personality factors that play a role in the adoption of appropriate actions to cope with natural hazards. For Baumann and Sims (1978) personality rather than rationality is a distinguishing feature separating out those who purchase insurance coverage from those that do not.

Another perspective on insurance is as a management tool for natural hazards. Arnell and Gurnell (1994) have illustrated the significant influence of governments and public authorities on lending institutions and on the public. They suggest that insurance policy led by governments or other authorities can serve as an overall hazard mitigation policy relevant to different types of extreme events and for diverse population groups. Analyzing past events, they show how major developments and adjustments to hazards have tended to develop as a response to a single, specific event rather than as part of a general policy. Insurance can also be a way of sharing the burden of hazards between individuals and across time periods. Hudson et al. (2016) have developed an integrated model of household level mitigation behavior and flood insurance premiums that shows how incentivizing flood insurance is able to promote adaptation, reduce risk and is more affordable than incentivizing damage reduction. Over the long term, a link between flood insurance and damage reduction has been found in the UK. This raises the issue of the role of insurance in affecting human behavior in the face hazards: encourage people to move or stay in areas prone to disasters. A case study from Germany (Schwarze and Wagner, 2007) however illustrates the limits of government. In this instance an attempt to institute compulsory flood insurance failed due to the existence of a state guarantee to cover large claims and the questionable legality of forcing people to purchase insurance.

Other recent work looking at aggregate patterns of demand for flood insurance in the US has shown unsurprisingly that counties along the coast have higher rates of flood insurance purchasing as well as counties with highly developed land within floodplains. This work also highlights that the price of insurance premia seems to have a very small impact. One of the most important findings is the significance of risk perception in the decision whether to purchase insurance or not. Recent flood events and the memories of flood experiences significantly increase demand. Demographic variables such as education and age were also found to be significant. Age-group and education were found to be directly related to demand. Race was found to have a similar affect: areas with higher concentration of African-Americans, all other things equal, generate higher insurance demand (Atreya et al., 2015).

Surprisingly, living in areas more vulnerable to flooding does not necessarily mean a greater demand for insurance than in areas less vulnerable. Botzen and van den Bergh, (2012) show that inhabitants of unprotected flood areas in the US have a

lower propensity to pay for flood insurance. These results imply that flood insurance can be targeted to inhabitants of areas that are protected against flooding, since these individuals seem to realize that flood prevention infrastructure cannot guarantee complete protection.

A study of demand for flood insurance in Florida (NFIP policies-in-force; Michel-Kerjan and Kousky, 2010) reports more than 80% of flood policies are for single-family, residential properties and are short-lived. Even if people decide to purchase insurance they drop coverage quickly (half after 3 years). A drop of 62% in coverage is reported after five years and may be explained by the lack of flooding activity over that period. Additionally, the share of single-family policy holders with maximum coverage available grew steadily from 2000 to 2005. Policy holders with higher levels of building coverage tend to have higher levels of contents coverage, and this is also positively correlated with income measures.

Cultural differences and biases might also have a significant role in the decision to purchase insurance. Evidence shows that Americans for example tend to see themselves as living longer and believe their neighborhoods are safer and better prepared for disaster than other places. Japanese on the other hand tend to believe their own area is more at risk and less well prepared. Such differences in perception lead to differences in demand for insurance (Myers, 1992; Palm and Carroll, 1998 in: Palm, 1998).

Most research regarding hazard insurance focusses on developed countries, mainly the US and Europe. Insurance in developing countries is hardly affordable. Only 1% of the population in low-income countries has catastrophe coverage and only 3% in middle-income countries, compared with 30% in high-income countries (Munich Re, 2005 in: Linnerooth-Bayer and Mechler, 2006). However it should be noted that insurance can be a possible adaptation strategy in developing countries as well, with help and support of international institutions and local organizations to develop such strategy.

3. Household Preference for Insurance and the Generation of Resilience: A Model

In this section we present a theoretical framework for thinking about how household preference for insurance can ultimately contribute to community resilience. As insurance allows recovery from loss it is a central measure of resilience. We follow standard practice by assuming that a household attempts to maximize expected utility (EU) from two sources: endowed wealth and property value. The latter is exposed to natural hazards and needs to be insured in order to maintain EU. Much of the literature deals with the optimal level of insurance and its price in order to attain EU (Smith 1968). Following Lee (2007) we adopt an extended form of utility comprised of two factors: income and wealth (embodied in property value). From income, the household acquires insurance coverage and also many forms of consumption goods. From property, the household derives benefits via a continual stream of service flows. Protecting against a natural hazards decreases income as it forces the household to trade off between acquiring insurance coverage or more consumption goods. It also impacts on wealth as it decreases the value of the property and the service flows that it generates. When acquiring insurance the household equates its marginal utility of goods consumption with that derived from service flows. However timing is very important. The household makes the initial decision to purchase insurance in the first time period (t_0). The utility in the second time period (t_1) is dependent on whether a hazardous event occurs between times (t_0) and (t_1). Maximizing utility means equating the marginal utility of the 1st period consumption with that of the 2nd period wealth

Consider a household with initial (pre-hazard) wealth W_0. The resilience of this household post-hazard (W_1), will be conditioned on the loss it incurs (L) through the magnitude of the natural hazard and its' ability to 'weather the storm' through insurance, government assistance etc (R) ie $W_1 = W_0 - L + R$. L is comprised of the pre-hazard level of wealth mediated by the magnitude of the natural hazard (M) and the rate of loss that this dictates (γ) such that for a household from population group i:

$$L = W_{0i}\gamma_i(M) \quad . \qquad (1)$$

where $0 < \gamma_i < 1$ and $\gamma_i^{'} > 0$ for any $M > 0$.

Recovery from loss is a measure of resilience (*R*). A central component of *R* is insurance coverage. However gross expenditure on insurance does not tell the whole story. Resilience is really captured by the relationship of level of insurance to the value of the property being insured (ie coverage level). For example, if a natural hazard damages two properties, one expensive and one cheap, the actual value of the damage (much greater for the expensive property) still tells us very little about resilience. Only if we know about the level of coverage of the expensive versus the cheap property can we say something about the recovery chances of the respective households owning those properties. Household welfare is therefore affected by level of coverage rather than gross value of damage.

Empirical evidence on the demand for insurance (see above) suggests that socio-economic factors such as gender, race, income group, age and previous hazard experience all mediate the decision to acquire insurance. In addition, specific local conditions such as topography and location will dictate the level of coverage which will vary across different hazard zones. Finally, socio-psychological factors such as misperception of risk, herd-like behavior, lack of accurate information, over-confidence ("it-won't-happen- here") and minimalizing low probability events can all play havoc with attempts to estimate demand. All these features combine to generate a probability of insurance coverage δ which itself is contingent on W_0. Given these features, we define the insurance coverage level (*C*) of a household in location *j* as comprised of a premium (*p*) which is a function of initial wealth W_0 and local specific hazard premium (C_j), such that:

$$C = C_j(p) \text{ where, } p = p(W_0) \text{ and } p^{'} > 0. \qquad (2)$$

Insurance-based resilience can now be defined as:

$$R = \delta(W_0)\min\{C, L\} \text{ where } \delta^{'} > 0 \qquad (3)$$

The post recovery situation of household *i* in location *j* (a measure of its resilience), given a hazard *M* and an initial wealth level W_0 will now be:

$$W_{1ij}(M, W_0) = W_0 - L + R \qquad (4)$$

Substituting for *L* and *R*:

$$W_{1ij} = W_0 - W_0\gamma_i(M) + \delta(W_0)\min\{C_j(pW_0))W_0\gamma_i(M)\} \qquad (5)$$

As ownership of a residence is a key source of household wealth, the role of property insurance is an important ingredient of household resilience. Aggregating households into communities, we can now define a measure of community resilience (*CR*) that incorporates aggregate household preference for insurance. This is simply the sum of the individual values of W_{1ij} in relation to some minimum level of W i.e. a minimum policy-defined lower limit beyond which poverty will not fall (W^*). If $W_1 / W^* < 1$ then intervention is necessary to increase resilience. Alternatively, if $W_1 / W^* > 1$ then no policy measures are needed.

Community resilience is therefore defined as the sum of the marginal changes in wealth with respect to natural hazard *M* in relation to some minimum (pre-defined) level of resilience:

$$CR = \left[\Sigma(\partial W_{1ij} / \partial M) / \Sigma(W_{1ij} / W^*)\right]^{1+\alpha} \qquad (6)$$

where $\alpha \geq 0$ denotes a policy weight. The larger the value of α, the larger the intervention to stop the community falling below W^*.

4. Trends in Household Insurance in Israel

As in other places, household insurance in Israel covers both structure and contents. Structure insurance is compulsory for households purchasing a residence on the basis of a mortgage. In many instances, on completion of their mortgage payments, households do not renew their structure insurance. This of course exposes their vulnerability and can undermine household and community resilience in the aggregate. Furthermore when faced with natural hazards, structure insurance does not include the land on which the building stands. This further exposes households and communities in areas where land and structures are threatened.

In the case of natural hazards and war related damage (eg missile damage) the national government runs a National Compensation Fund (NCF) capitalized from property tax revenues. In the event of a damage to be covered by the NCF (a decision made by central government) private insurance coverage is frozen and the government funds covers building structure and content. Damage to structures is assessed by government assessors and generally reflects the (under) assessments of private insurance assessors. With respect to content coverage, there is often a large discrepancy between NCF and private insurance assessment to the detriment of the insurance purchaser. NCF has a standard-scale inventory of household content compensations based on household size and assessed needs. In addition contents assessments are evaluated at present value rather than replacement (ie new) value. Both the factors mean that NCF insurance compensation is generally at a lower level than that commercially available.

Table 1: Aggregate Trends in Household Insurance in Israel 2005-2015

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1. # DU's with compreh. insurance (th)	943	862	872	848	939	991	1049	1,103	1,070	1,170	1,158
2.# DU's with mortgage insurance (th)	493	454	465	397	371	370	364	349	328	322	304
(2) as % of (1)	52.3	52.6	53.3	46.8	44/2	37.3	34.7	31.6	30.6	27.5	26.2
Gross value of resid. insurance coverage (M Sh)	1,050	1,090	1,152	1,220	1,265	1,330	1,435	1,515	1,569	1,608	1,620

Source: Annual Reports, The Authority for Capital Markets, Insurance and Savings, Ministry of Finance, Jerusalem, http://mof.gov.il/

Table 1 and Fig 1 show that the number of dwelling units (DU's) with comprehensive insurance has increase by 23% across the preiod 2005- 2015. In contrast, DU's with mortgage insurance has declined by 38% over the same time frame. These could indicate a slow down in completion of new apartments over this period with less people buying new houses and taking morgtages. Alteratively it could suggest an increase in house purchases that by-pass the mortgage market, funded by inheritance or personal capital or a rise in awarness for home insurance and its importance. This would result in more people purchasing comprehensive insurance rather than just mandatory morgtage insurance.

Fig 1: Dwelling units with comprehensive insurance and with mortgage insurance in Israel, 2005-2015

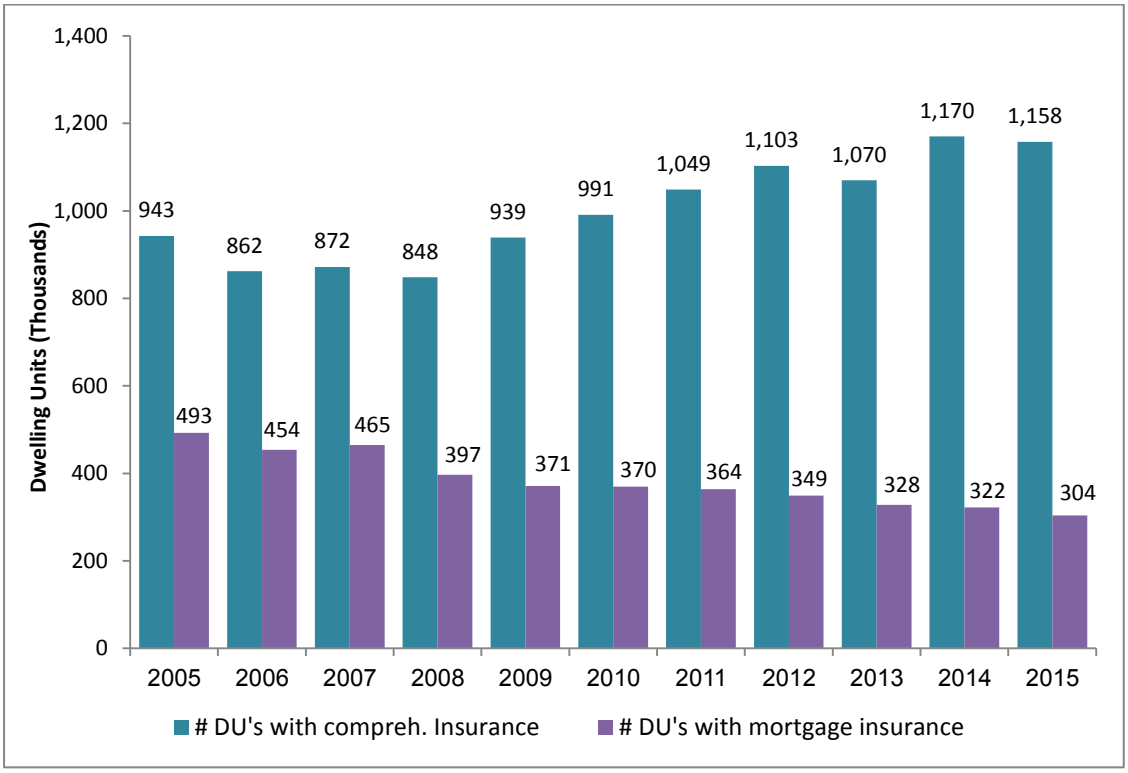
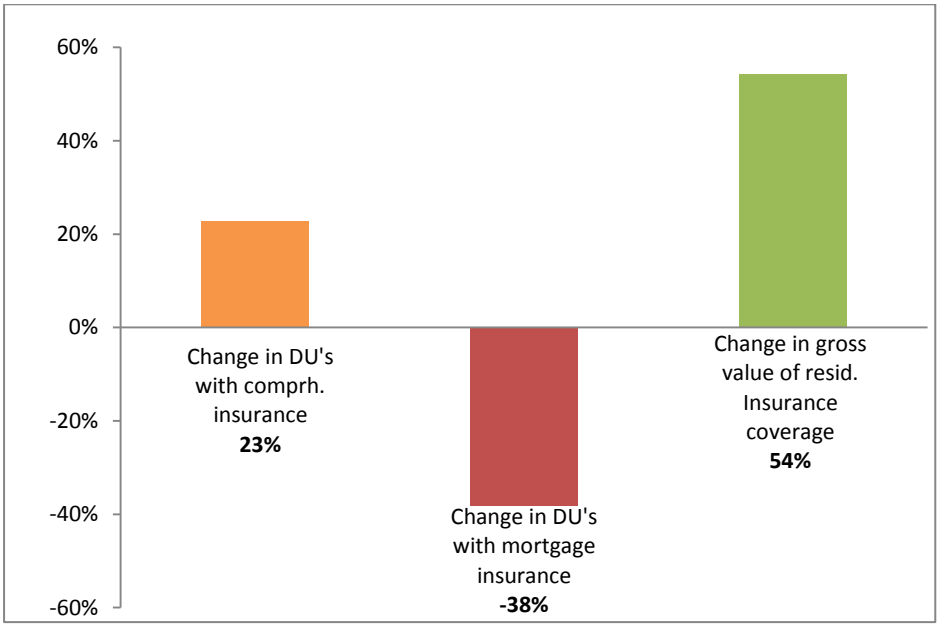
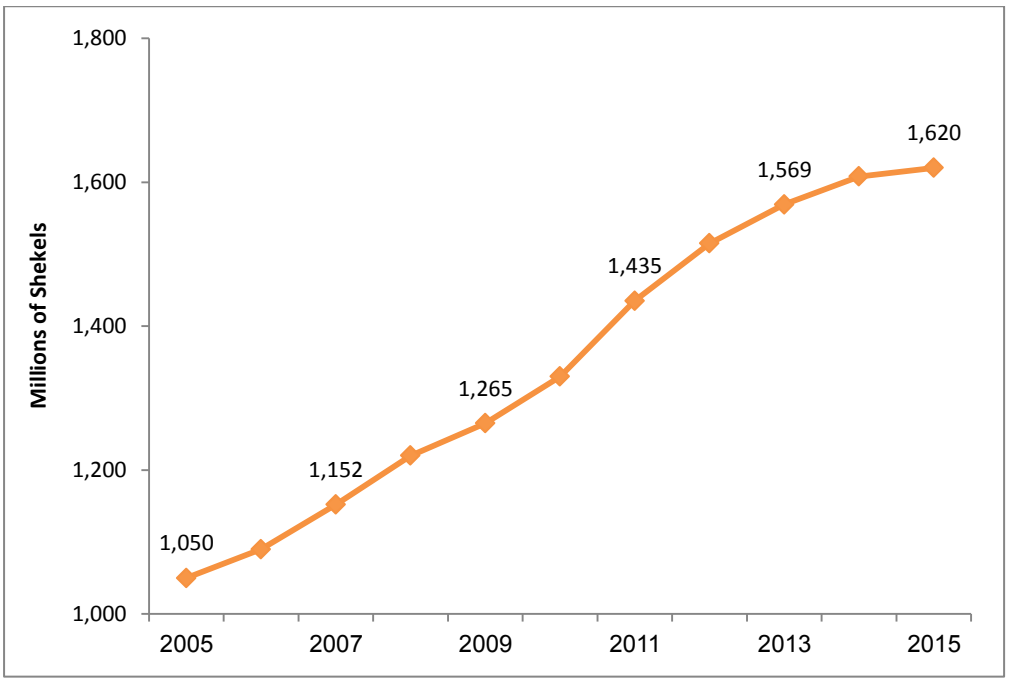


Fig 2: Change in demand for insurance and value of insurance coverage in Israel, 2005-2015



Interestingly, the gross value of residential insurance coverage has risen by 54% over the period, which is much higher than the change in dwelling units with comprehensive insurance (23%) (Fig 2). This might reflect a rise in the value of insurance premia: households already paying for insurance are paying more or simply it captures rise in the basic cost of coverage. This rise may also reflect a rise of standard of living and wealth with households accumulating more valuable properties and contents that need to be protected. It may also be indicative of a rising awareness of the need to protect against unpredictable events.

Fig 3: Gross value of residential insurance coverage in Israel, 2005-2015



5. Household Insurance in the Study Area

We use insurance coverage data from the annual Israel Central Bureau of Statistics (CBS) Household Expenditure Survey (HES). This is micro data aggregated to the level of the Statistical Area (SA). Our study area encompasses (98) SA's comprising the Haifa metropolitan area and we utilize CBS pooled cross section data specially prepared from the HES for the period 2009-2015 covering all SA's in Israel. Due to the nature of the survey, not all SA's nationally (or in the study area) have a sufficient amount of observations and thus SA coverage is not complete. Insurance

data relates to two variables: (1) average monthly expenditure on insurance by household and (2) share of insurance expenditure out of total monthly household expenditure. In the survey, 'household insurance' makes no distinction between structure and content insurance.

Household insurance data is correlated with socio economic averages by SA (from the CBS Census of Population 2008) and SA average house prices for the period 1995-2015 in 2009 prices from the Carmen data base (Israel tax Authority). Other variables relate to demography (share of elderly population aged 65+ in the SA), ownership (share of owner occupied dwelling units in the SA) and median earnings in the SA (source is the National Insurance Institute 2013)

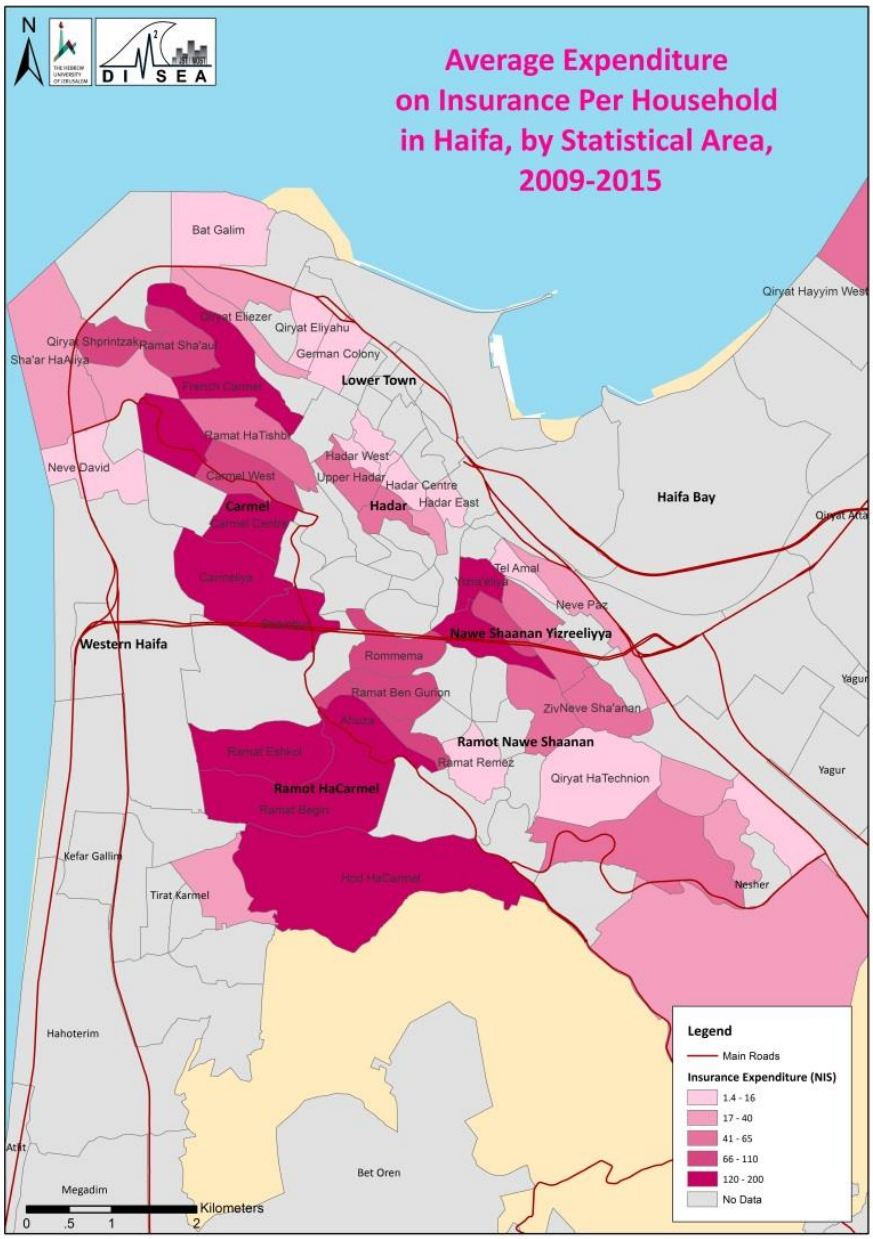
5.1. Mapping Household Insurance

For each insurance variable a series of maps are presented (Maps 1-6). Insurance coverage is mapped for the total Haifa metropolitan area and for two sub-areas, the city of Haifa and the Krayot suburbs.

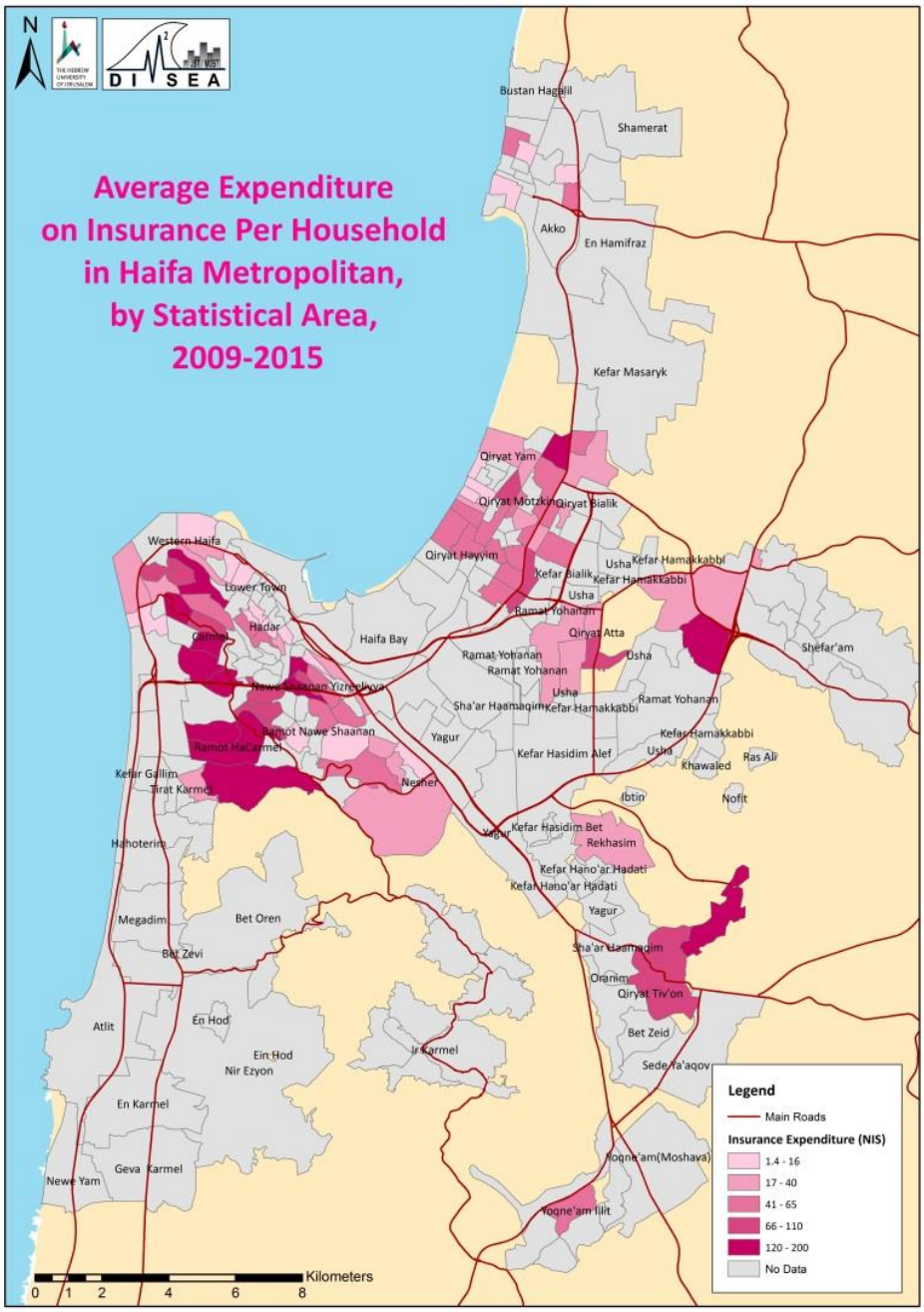
The SA's with the highest monthly expenditure on home insurance are mostly in the city of Haifa: Hod Ha'Carmel (202 NIS per month), Ahuza (157), Carmel Center (152), Carmeliya (140) and more. Areas outside Haifa with high expenditure include the north-eastern part of Qiryat Tiv'on (152 NIS), one SA in Qiryat Atta (122) and on SA in Qiryat Motzkin (122). SA's with low expenditure on home insurance are along the coast: Akko (11-63 63 NIS), Bat Galim in Haifa (13.4) Sha'ar Ha'aliya in Haifa(33), Qiryat Yam (1.5-64.7), Qiryat Hayyim (43-59) and more.

With respect to the share of home insurance expenditure out of all total household expenditure, the findings are very similar. SA's with high shares are Yizra'eliya (1.554%), Carmel Center (0.970%), Qiryat Tiv'on (0.880%), Hod Ha'Carmel (0.864%), Qiryat Motzkin (0.726%) and so on. Low rates of expenditure are again in Hadar in Haifa (0.070%), Nesher (0.046%), Akko (0.116%), etc. The two insurance variables are highly correlated, r=0.89. Average insurance expenditure is also correlated with the average share of home ownership in the SA, r=0.46 (Table 2)

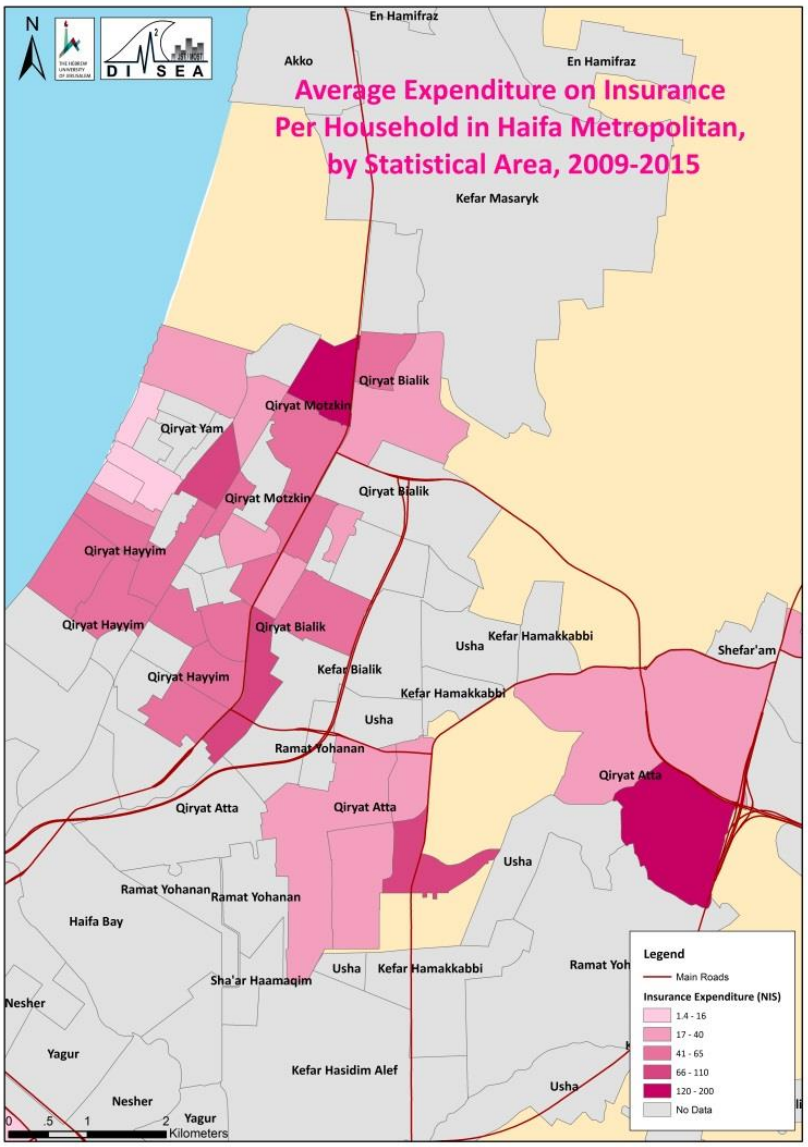
Map 1


Average Expenditure
on Insurance Per Household
in Haifa, by Statistical Area,
2009-2015
N
DI SEA
Bat Galim
Qiryat Hayyim West
Qiryat Eliezer
Qiryat Eliyahu
Qiryat Shprintzak
Ramat Sha'ul
Sha'ar HaAliya
German Colony
Lower Town
French Carmel
Ramat HaTishbi
Hadar West
Neve David
Carmel West
Upper Hadar
Hadar Centre
Carmel
Hadar
Hadar East
Haifa Bay
Qiryat Atta
Carmel Centre
Tel Amal
Carmeliya
Neve Paz
Nawe Shaanan Yizreeliyya
Western Haifa
Rommema
Yagur
Ramat Ben Gurion
ZivNeve Sha'anan
Ramot Nawe Shaanan
Ramat Remez
Qiryat HaTechnion
Ramot HaCarmel
Kefar Gallim
Tirat Karmel
Nesher
Hahoterim
Legend
Main Roads
Insurance Expenditure (NIS)
1.4 - 16
17 - 40
41 - 65
66 - 110
120 - 200
No Data
Atlit
Bet Oren
Megadim
Kilometers
0 .5 1 2

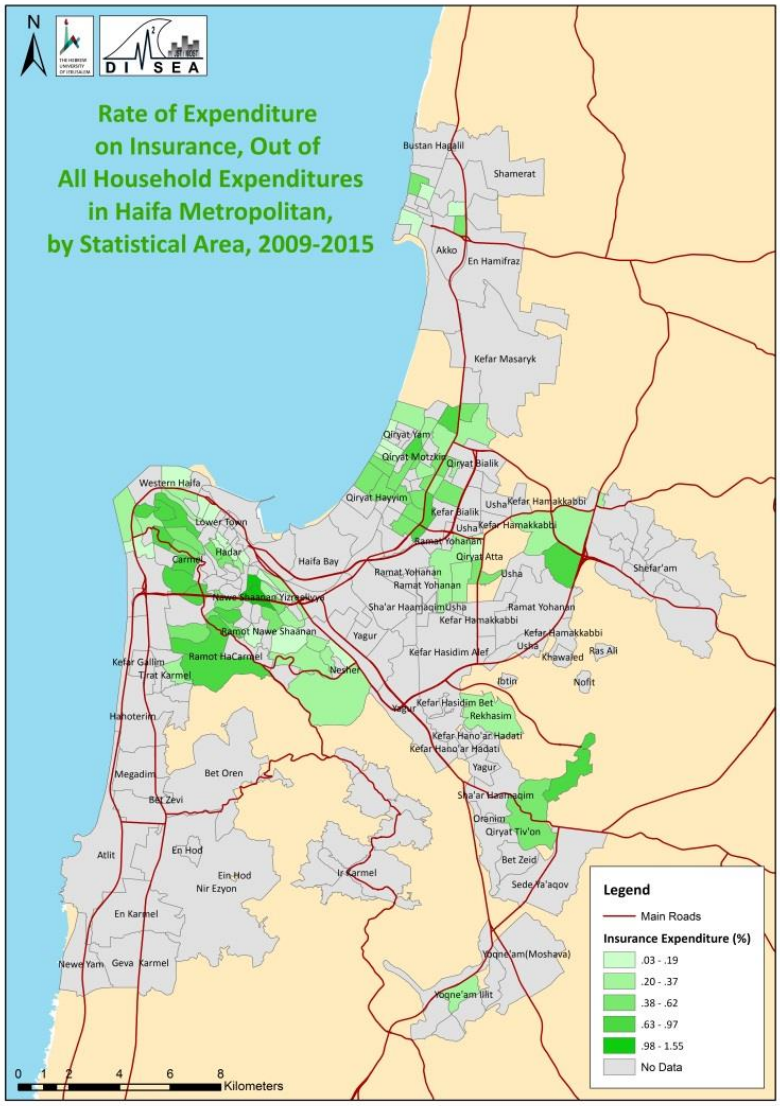
Map 2


Average Expenditure
on Insurance Per Household
in Haifa Metropolitan,
by Statistical Area,
2009-2015
N
DI SEA
Bustan Hagalil
Shamerat
Akko
En Hamifraz
Kefar Masaryk
Qiryat Yam
Qiryat Motzkin
Qiryat Bialik
Qiryat Hayyim
Kefar Bialik
Usha
Kefar Hamakkabbi
Ramat Yohanan
Qiryat Atta
Shefar'am
Western Haifa
Lower Town
Hadar
Carmel
Haifa Bay
Ramat Yohanan
Ramat Yohanan
Usha
Sha'ar Haamaqim
Kefar Hamakkabbi
Ramat Yohanan
Kefar Hamakkabbi
Usha
Ramot Nawe Shaanan
Ramot HaCarmel
Yagur
Kefar Hasidim Alef
Khawaled
Ras Ali
Kefar Gallim
Tirat Karmel
Nesher
Ibtin
Nofit
Kefar Hasidim Bet
Rekhasim
Hahoterim
Kefar Hano'ar Hadati
Kefar Hano'ar Hadati
Yagur
Megadim
Bet Oren
Bet Zevi
Sha'ar Haamaqim
Oranim
Qiryat Tiv'on
Atlit
En Hod
Bet Zeid
Ein Hod
Nir Ezyon
Ir Karmel
Sede Ya'aqov
En Karmel
Yoqne'am(Moshava)
Geva Karmel
Newe Yam
Yoqne'am Ilit
Legend
Main Roads
Insurance Expenditure (NIS)
1.4 - 16
17 - 40
41 - 65
66 - 110
120 - 200
No Data
Kilometers
0 1 2 4 6 8

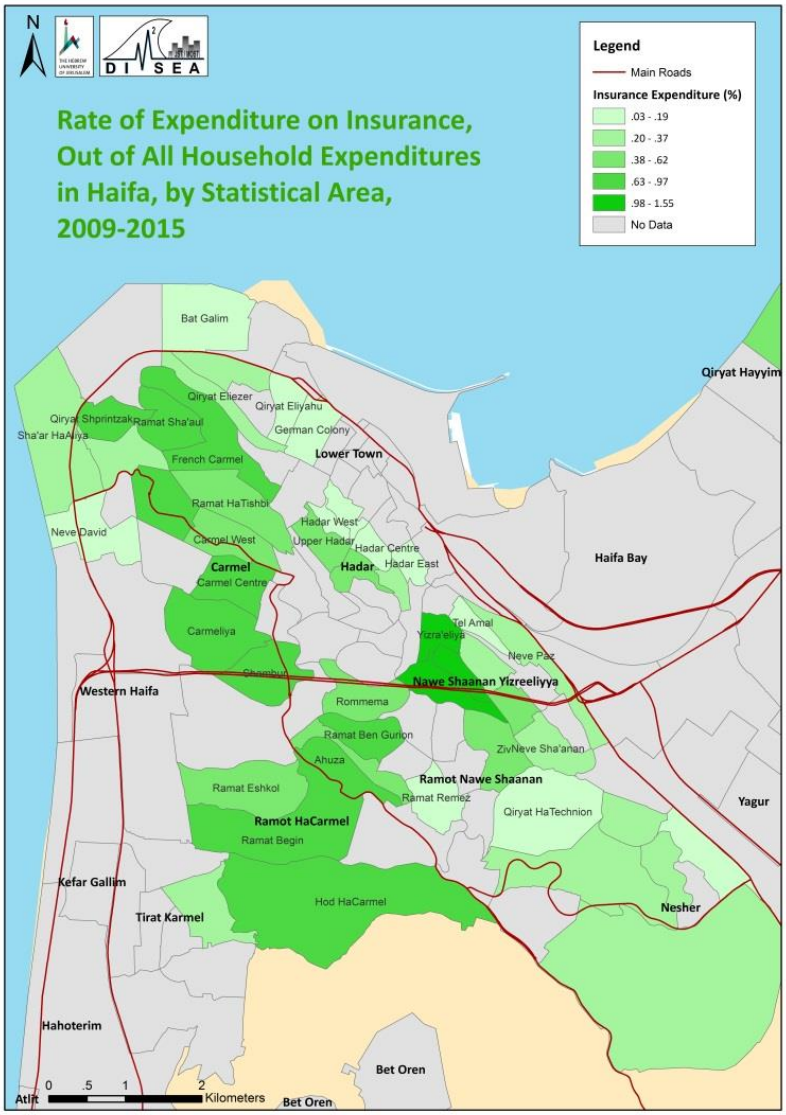
Map 3


Average Expenditure on Insurance
Per Household in Haifa Metropolitan,
by Statistical Area, 2009-2015
N
D I S E A
En Hamifraz
Akko
En Hamifraz
Kefar Masaryk
Qiryat Bialik
Qiryat Motzkin
Qiryat Yam
Qiryat Motzkin
Qiryat Bialik
Qiryat Hayyim
Qiryat Hayyim
Qiryat Bialik
Kefar Hamakkabbi
Usha
Shefar'am
Qiryat Hayyim
Kefar Bialik
Kefar Hamakkabbi
Usha
Ramat Yohanan
Qiryat Atta
Qiryat Atta
Qiryat Atta
Usha
Ramat Yohanan
Ramat Yohanan
Haifa Bay
Usha
Kefar Hamakkabbi
Ramat Yoh
Sha'ar Haamaqim
Nesher
Yagur
Kefar Hasidim Alef
Usha
Nesher
Yagur
0 .5 1 2 Kilometers
Legend
Main Roads
Insurance Expenditure (NIS)
1.4 - 16
17 - 40
41 - 65
66 - 110
120 - 200
No Data

Map 4


N
DI SEA
Rate of Expenditure
on Insurance, Out of
All Household Expenditures
in Haifa Metropolitan,
by Statistical Area, 2009-2015
Bustan Hagalil
Shamerat
Akko
En Hamifraz
Kefar Masaryk
Qiryat Yam
Qiryat Motzkin
Qiryat Bialik
Qiryat Hayyim
Kefar Bialik
Usha
Kefar Hamakkabbi
Ramat Yohanan
Qiryat Atta
Shefar'am
Western Haifa
Lower Town
Hadar
Carmel
Haifa Bay
Nawe Shaanan Yizre'el Ivri
Sha'ar Haamaqim
Ramot Nawe Shaanan
Yagur
Kefar Hasidim Alef
Khawaled
Ras Ali
Kefar Galim
Tirat Karmel
Ramot HaCarmel
Neshef
Ibtin
Nofit
Kefar Hasidim Bet
Rekhasim
Hahoteriim
Kefar Hano'ar Hadati
Kefar Hano'ar Hadati
Megadim
Bet Oren
Bat Zevi
Oranim
Qiryat Tiv'on
Atlit
En Hod
Ein Hod
Nir Ezyon
Ir Karmel
Bet Zeid
Sede Ya'aqov
En Karmel
Yoqne'am(Moshava)
Newe Yam
Geva Karmel
Yoqne'am Ilit
Legend
Main Roads
Insurance Expenditure (%)
.03 - .19
.20 - .37
.38 - .62
.63 - .97
.98 - 1.55
No Data
0 1 2 4 6 8
Kilometers

Map 5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Rate of Expenditure on Insurance, Out of All Household Expenditures in Haifa, by Statistical Area, 2009-2015
Legend
Main Roads
Insurance Expenditure (%)
.03 - .19
.20 - .37
.38 - .62
.63 - .97
.98 - 1.55
No Data
Bat Galim
Qiryat Hayyim
Qiryat Eliezer
Qiryat Eliyahu
Qiryat Shprintzak
Ramat Sha'aul
Sha'ar HaAliya
German Colony
Lower Town
French Carmel
Ramat HaTishbi
Hadar West
Neve David
Carmel West
Upper Hadar
Hadar Centre
Hadar East
Hadar
Carmel
Carmel Centre
Haifa Bay
Carmeliya
Tel Amal
Yizra'eliyya
Neve Paz
Shemuel
Nawe Shaanan Yizreeliyya
Western Haifa
Rommema
Ramat Ben Gurion
Ahuza
ZivNeve Sha'anan
Ramot Nawe Shaanan
Ramat Eshkol
Ramat Remez
Qiryat HaTechnion
Yagur
Ramot HaCarmel
Ramat Begin
Kefar Gallim
Hod HaCarmel
Nesher
Tirat Karmel
Hahoterim
Bet Oren
Atlit
0 .5 1 2 Kilometers
Bet Oren

Map 6

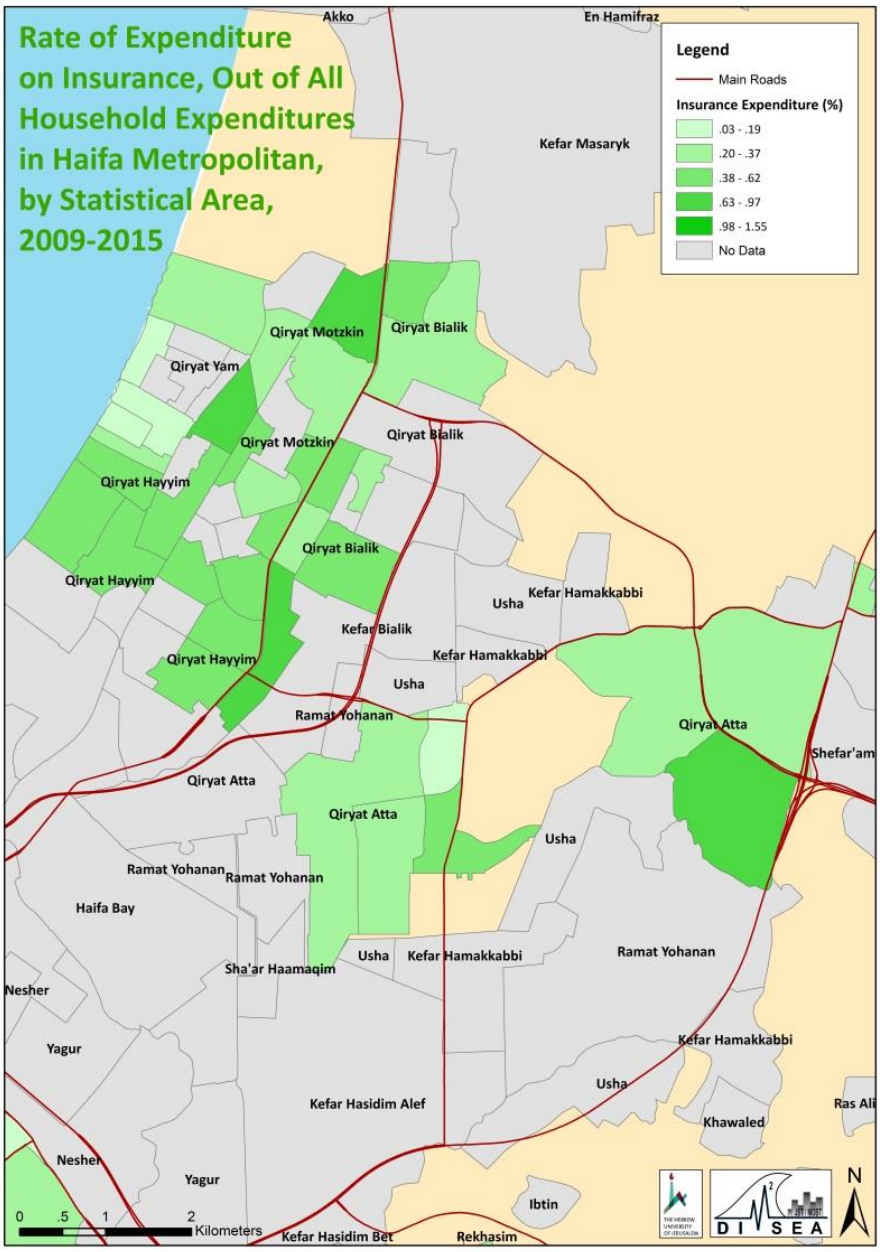

Rate of Expenditure on Insurance, Out of All Household Expenditures in Haifa Metropolitan, by Statistical Area, 2009-2015
Legend
Main Roads
Insurance Expenditure (%)
.03 - .19
.20 - .37
.38 - .62
.63 - .97
.98 - 1.55
No Data
Akko
En Hamifraz
Kefar Masaryk
Qiryat Motzkin
Qiryat Bialik
Qiryat Yam
Qiryat Hayyim
Usha
Kefar Hamakkabbi
Kefar Bialik
Ramat Yohanan
Qiryat Atta
Shefar'am
Haifa Bay
Sha'ar Haamaqim
Nesher
Yagur
Kefar Hasidim Alef
Khawaled
Ibtin
Kefar Hasidim Bet
Rekhasim
0 .5 1 2 Kilometers
N
DISEA

Table 2: Home Insurance Expenditure in the Haifa Metropolitan Area, 2009-2015

	Home-ownership (%)	Avg. expenditure on home insurance (NIS)	Avg. Expenditure on insurance out of all h'hold expenditure (%)
Weighted Mean**	74.358	55.157	0.430
SD	11.063	43.805	0.277
Correlation with avg. expenditure (NIS)	0.462		0.895

Total Households sampled in the survey (in Haifa metro area):3,799 out of 147,412 households in the population

* Data processed from the annual CBS household expenditure survey and based on 92 statistical areas in the Haifa Metropolitan area

** by # households in the survey for each statistical area;

5.2. Comparing Haifa with other Cities in Israel

The average level of insurance coverage in the Haifa metropolitan area is slightly higher than the national urban average in Israel (55.2 NIS monthly compared to 52.4). However it falls below the average for other large Israeli cities such as Tel Aviv (72.4 NIS), Modi'in (74.9) and Rishon Le'Zion (61.2) but is higher than Jerusalem (45.7), Ashdod (33.7) and Netanya (36.5). Interestingly, cities in high risk zones such as Tiberias and Tzfat (earthquake), or Ashdod and Netanya (inundation from the sea) record low averages (14.5-36.5 NIS). This could imply that many households are not insured at all or are insured at very basic premium. Unsurprisingly, Arab localities such as Um al-Fahem, Yanuah-Jat and Majdal Shams are at the bottom of the rankings with minimal monthly insurance expenditure.

Table 3: Average Expenditure on Household and Average Expenditure out of All Household Expenditures in Israel, Haifa Metropolitan and Selected Localities in Israel, 2009-2015

Variable/Locality	**Total number of households sampled in the survey**	**Total number of households in the population**	**Number of SA**	**A1.Average Expenditure (NIS) Weighted Mean**	**SD**	**A2. Average Expenditure out of all household expenditures (%) Weighted Mean**	**SD**	**r (correlation between A1 and A2)**
Israel - Total	25,941	1,098,045	657	52.435	47.542	0.333	0.226	0.864
Haifa Metropolitan Area	3,799	147,412	98	55.157	43.805	0.430	0.277	0.895
Tel Aviv - Yafo	1,860	91,725	49	72.430	55.090	0.381	0.222	0.908
Jerusalem	1,461	62,412	37	45.698	27.579	0.310	0.149	0.928
Rishon Le'Zion	1,036	47,010	28	61.169	41.489	0.373	0.202	0.969
Be'er Sheva	843	37,373	21	39.499	32.524	0.278	0.187	0.916
Ashdod	826	30,889	21	33.743	20.106	0.245	0.120	0.882
Netanya	777	33,884	19	36.462	26.717	0.256	0.152	0.917
Ashkelon	636	33,403	16	37.783	35.203	0.258	0.181	0.984
Bnei Brak	543	18,566	14	30.556	20.602	0.239	0.146	-
Modi'in-Makkabim-Re'ut	403	15,729	9	74.859	25.085	0.345	0.071	-
Eilat	216	9,289	6	38.004	27.433	0.271	0.148	-
Zefad	107	3,200	3	14.525	9.849	0.122	0.053	-
Tiberias	31	1,219	2	27.614	19.957	0.231	0.135	-
One SA localities								
Omer	56	2,183	1	120.586	-	0.537	-	-
Yeruham	52	2,502	1	62.120	-	0.490	-	-
Yanuah-Jat	41	2,339	1	6.639	-	0.045	-	-
Majdal Shams	37	1,995	1	0.000	-	0.000	-	-

Caesarea	36	1,286	1	229.518	-	0.640	-	-
Um al-fahem	34	961	1	0.000	-	0.000	-	-
Savyon	30	1,218	1	495.610	-	0.984	-	-
Netivot	30	1,129	1	24.271	-	0.173	-	-

Fig 4: Average Expenditure on Home Insurance in Israel, Haifa Metropolitan Area and Selected Localities in Israel, 2009-2015

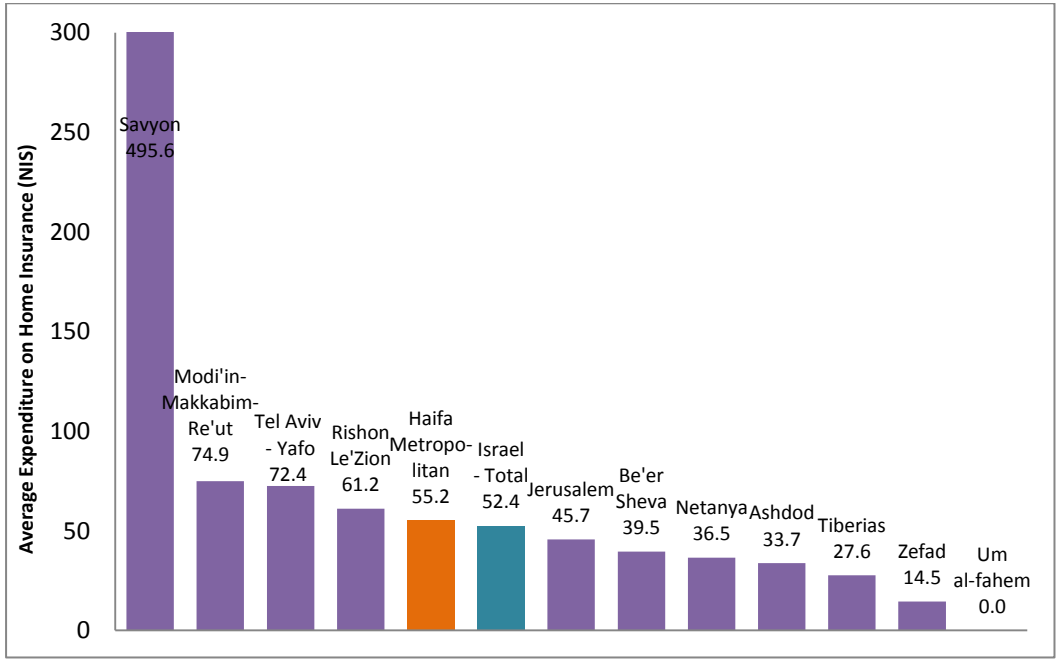
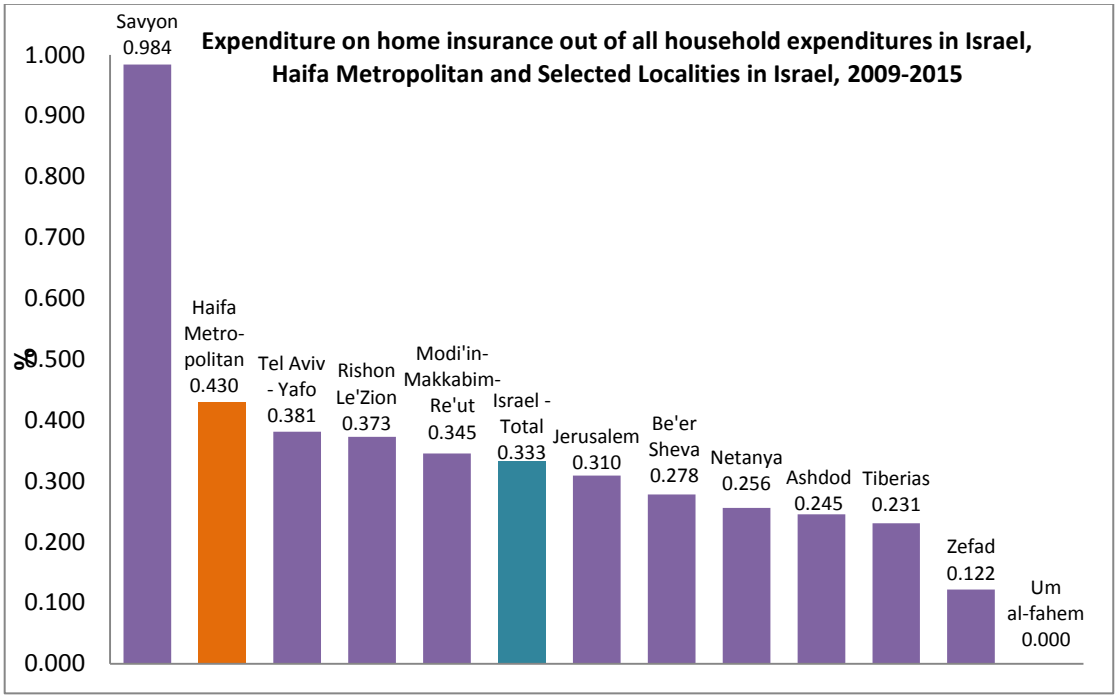


Fig 5: Expenditure on home insurance out of all household expenditures in Israel, Haifa Metropolitan and Selected Localities in Israel, 2009-2015



5.3. Household Insurance and Socio Economic Attributes

As noted above (sections 2 and 3) the propensity to insure in the face of hazards (i.e. demand for household insurance) is conditioned in part on the socio-economic attributes of the population of insurers. Age, education, wealth and property tenure are likely to affect behavior. We capture this behavior both in term of its magnitude (gross amount of insurance expenditure) and intensity (relative share of household insurance expenditure out of all expenditure).

Table 4 shows that population characteristics such as earnings and education are more highly correlated than housing attributes. This seems to reinforce the social-behavioral motivation for insurance that is driven by preferences related to personal characteristics more than objective features of the property to be insured. The bivariate relationships between income and education on the one hand and volume of expenditure on insurance on the other, seems to reinforce this (Figs 6,7). However a fuller understanding of these relationships needs to be addr4essed in a multivariate framework.

Table 4: Correlation between socio-economic attributes and home insurance expenditure variables

Variable	Average expenditure on home insurance (NIS; Log)	Percentage of expenditure on home insurance out of all households' expenditures
Average housing value per meter (NIS; Log)	0.378	0.534
Share of owner occupation	0.318	0.230
Percent of population aged 65+	0.066	0.205
Median yearly earnings (NIS; Log)	0.749	0.538
Percent of population with academic accreditation	0.458	0.469

Fig 6: Bivariate Relationship between Average Expenditure on Home Insurance and Median Yearly Earnings in the Haifa Metropolitan Area

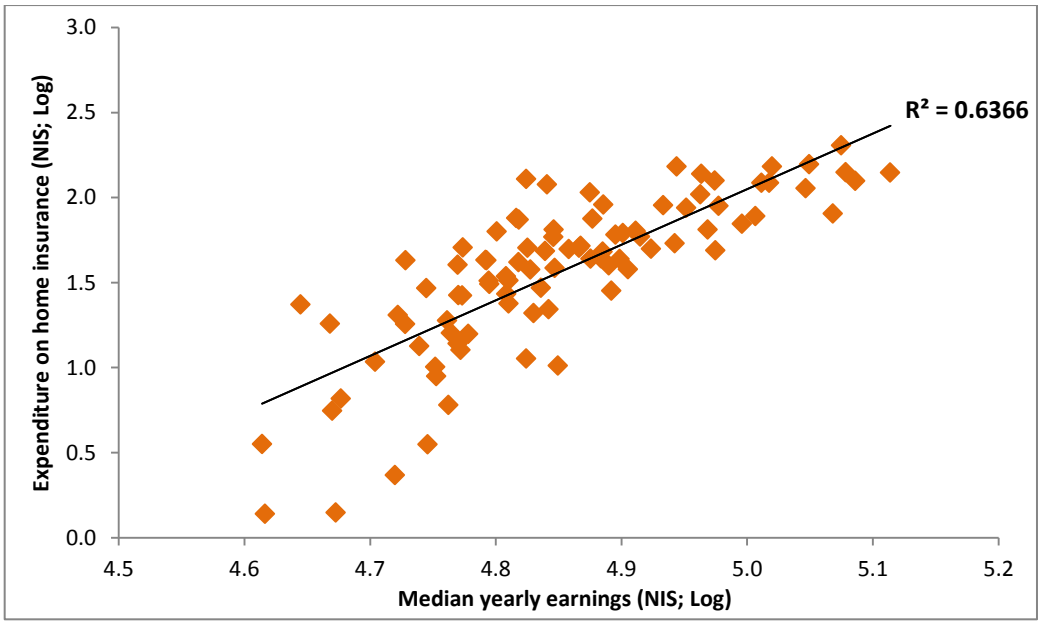
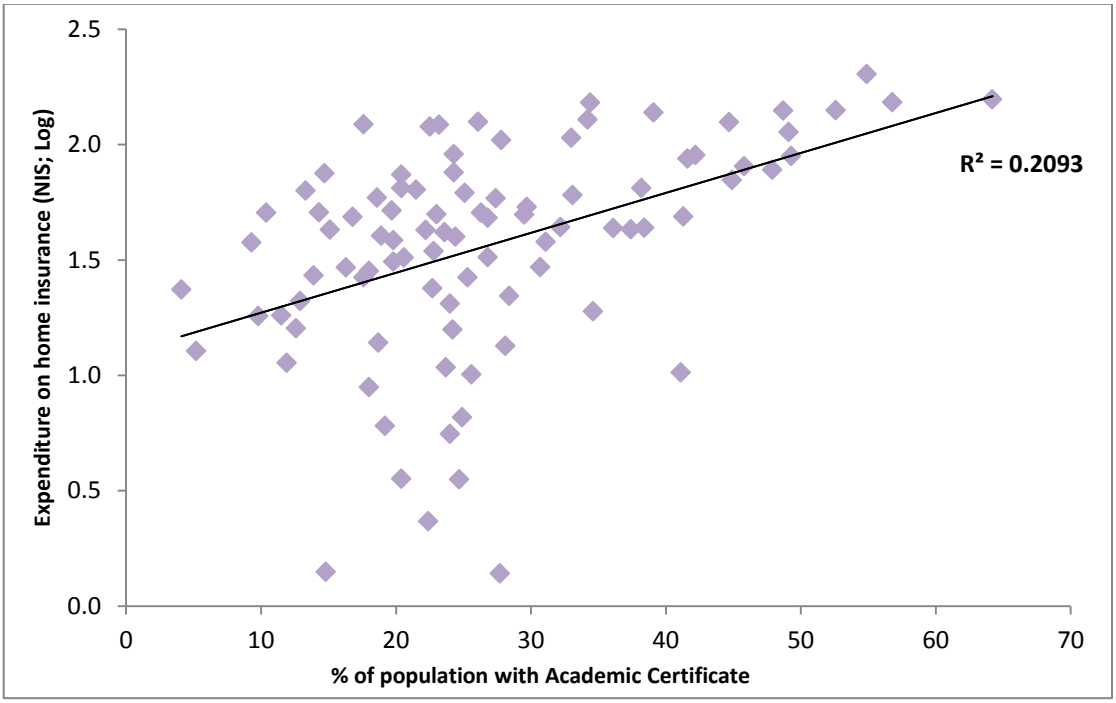


Fig 7: Bivariate Relationship between Average Expenditure on Home Insurance and Population with Academic Education in the Haifa Metropolitan Area



To this end, we test for a causal relationship between socio-economic attributes and insurance behavior and present the results of four OLS models (Table 5). The models test the hypothesis that household preference insurance is directly related to personal attributes of the insurer (age, religion, education, income level) and characteristics of the property being insured (value, ownership tenure). The possibility of endogeneity between housing attributes such as house value and ownership share and insurance coverage should not be discounted. Ideally, we could deal with this via instrumentation but given the limited nature of our data we do not have plausible instrument variables.

The models are estimated for two insurance variables and at two different spatial scales: the Haifa metropolitan area (n=~95) and nationally, (n=~530, including the Haifa observations). The results are relatively unanimous: the propensity to insure is related directly to income age, and ownership share both in Haifa and nationally. It is also related to the average value of dwelling units nationally but not locally (ie in Haifa). This relationship holds for insurance magnitude but not insurance intensity. As the estimation is in logs, the estimated elasticity is directly interpretable. A average rise of one percent in the average value of the dwelling units will generate an 0.028 percent average increase in insurance expenditure. A relationship of slightly greater magnitude is estimated with respect a rise in annual median incomes. A one percent rise in this variable will elicit a change of about 0.037 percent in average insurance intensity. A one percent rise in average ownership share or in the average population share of the elderly will elicit much smaller, but still positive, responses in terms of insurance behavior. It should be noted that given the unit of observation, all these results relate to changes in averages for statistical areas and in this respect the results are somewhat homogenized. Estimation based on real microdata would give us a much finer-grained perspective of human behavior. Despite the smaller number of observations the model fit for Haifa is slightly better than nationally perhaps due to the greater variance in national-level data.

Table 5; Estimating the Effects of Socio-Economic Characteristics on Insurance Behavior

VARIABLES	(1) Haifa Metrop LOG_EXPEND Log of average insurance expenditure	(2) Haifa Metrop LOG_SHARE Share of insurance expenditure of total expenditure	(3) National LOG_EXPEND Log of average insurance expenditure	(4)National LOG_SHARE Share of insurance expenditure of total expenditure
Log av.house price	0.6509	0.2410	0.2863***	0.0236
	(0.4877)	(0.1530)	(0.0803)	(0.0244)
Log median income	1.9860***	0.3643**	2.1230***	0.3888***
	(0.5670)	(0.1744)	(0.1406)	(0.0428)
Share of pop> 65	0.0254*	0.0177***	0.0086*	0.0094***
	(0.0135)	(0.0042)	(0.0050)	(0.0015)
Ownership share	0.0212***	0.0057**	0.0129***	0.0028***
	(0.0066)	(0.0022)	(0.0022)	(0.0007)
Constant	-21.4521***	-5.6236***	-18.5713***	-3.5822***
	(2.5782)	(0.8255)	(0.9864)	(0.2983)
Observations	95	98	522	531
R-squared	0.5634	0.4406	0.5271	0.2696

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.4. Household Insurance Coverage and Hazard Zones in the Haifa Metropolitan Area

We would expect to find spatial correlation between the geography of insurance cover and that of the hazard zones with more hazardous areas having greater levels of coverage. To analyze this relationship, we present a series of maps (Maps 7-10) that intersect the geography of household insurance coverage with that of different natural hazards. The latter include earthquake zones as defined by the National Geological Institute (Map7), fire zones as defined by contiguity with combustible vegetation (Map 8), proximity to river flood plains (Map 9) and proximity to sea inundation zones up to 2m (Map 10).

Given the low level of spatial resolution of earthhquake zones, most of the Hiafa metropolitan area falls under the same level of risk. A few reas are located on the border between the adjacent areas of expected different earthquake magnitudes. For example, Tirat Ha'Carmel has low average expenditure and adjacent area of Ramot Ha'Carmel in a higher hazard zone has higher expenditure. This is probably more related to different socio economic composition of these two contiguous districts than it is to their different hazard zones.

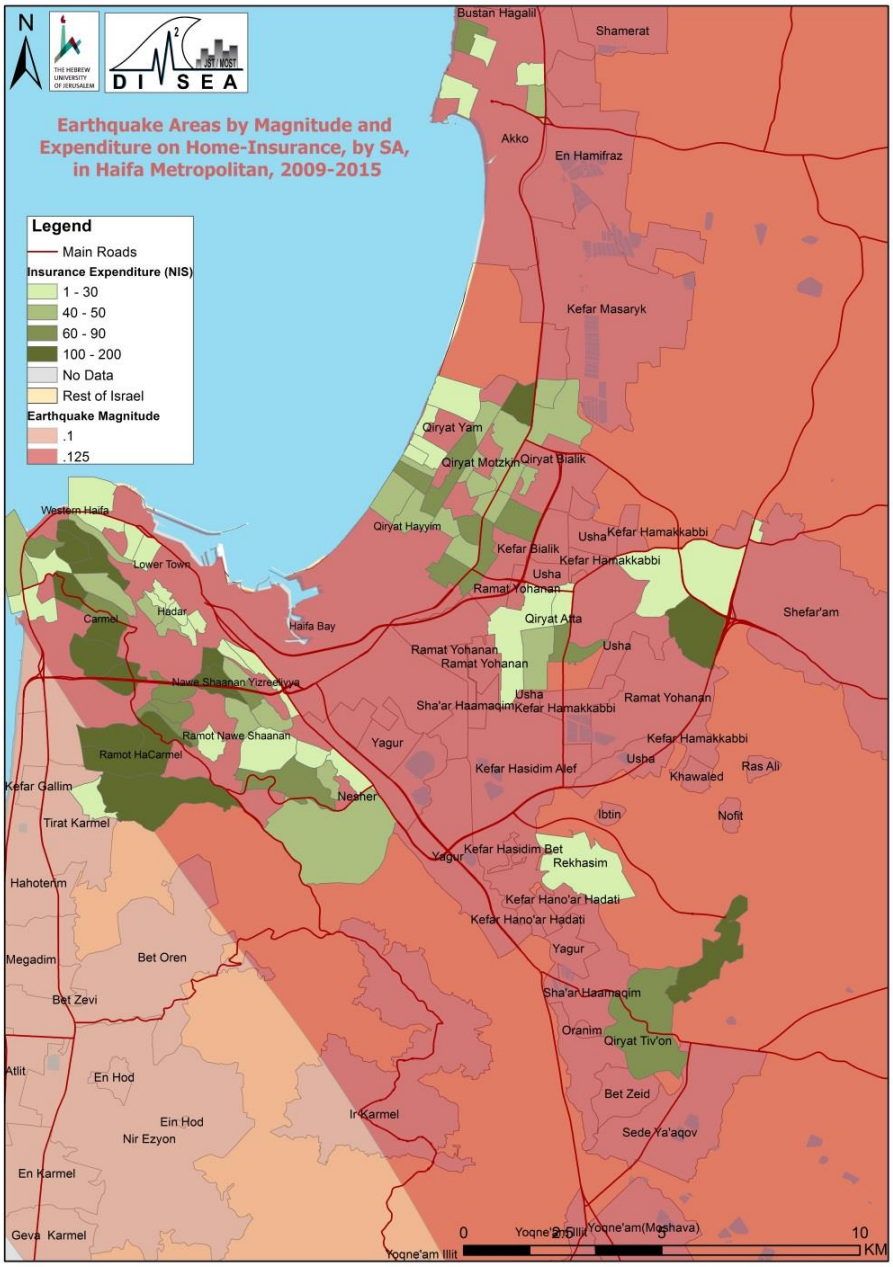
With respect to fires, Map 8 depicts zones with combustible vegetation which implies higher chance of fires due to the flammable natural environment. Most of combustible vegetation is on the Carmel range and very little exists in coastal areas. Qiryat Tiv'on, Qiryat Atta, Nesher and areas in Haifa like Carmel, Ramot Carmel, Ramat Ben Gurion, Romema, Yizreeliya are closer to combustible areas, making them more prone to fires. Generally, these areas have high expenditure on insurance.

In the case of river flooding, potential flood zones cover segments of the study area (Map 9). Most of the flood zone is in Haifa bay and to its east. Other areas in the city of Haifa that may be influenced by a case of river flooding are Hadar, the Lower Town area, Western Haifa, Carmel, Ramot HaCarmel, and more. Outside the city of Haifa, Qiryat Bialik, Qiryat Yam and Akko are also under risk. Generally, these areas have low average household insurance expenditure.

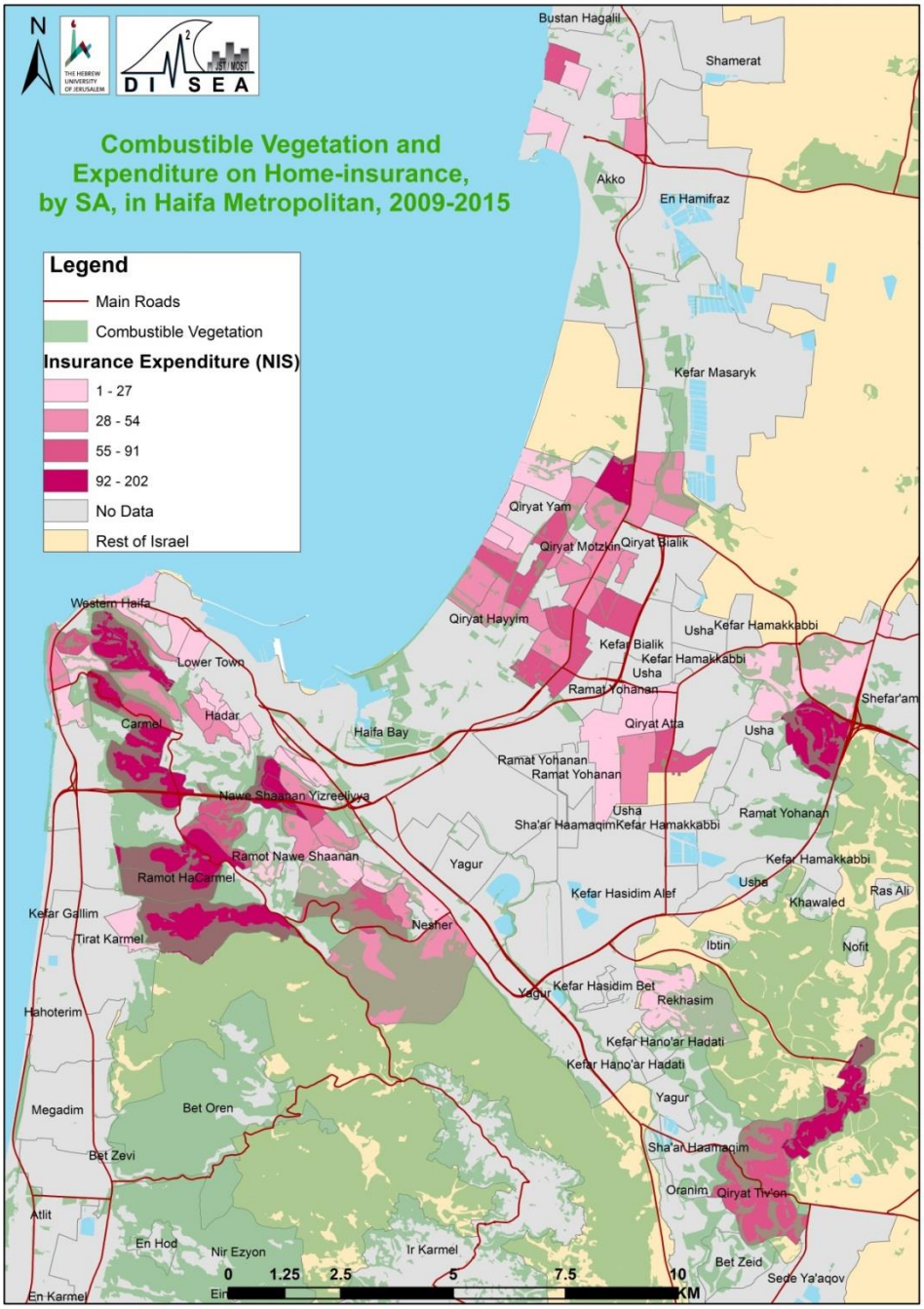
Inundation from the sea via SLR, storm surges etc. is an issue of concern in coastal settlements in Israel. Areas that might be affected from a 1-2 meter rise are those on the coast (Map 10). In our case study, in Haifa metropolitan these areas include: Bat Galim, Sha'ar Ha'aliya, Qiryat Hayyim West (all in Haifa), Qiryat Yam

and Akko. Almost all areas under threat are characterized by low level household insurance expenditure.

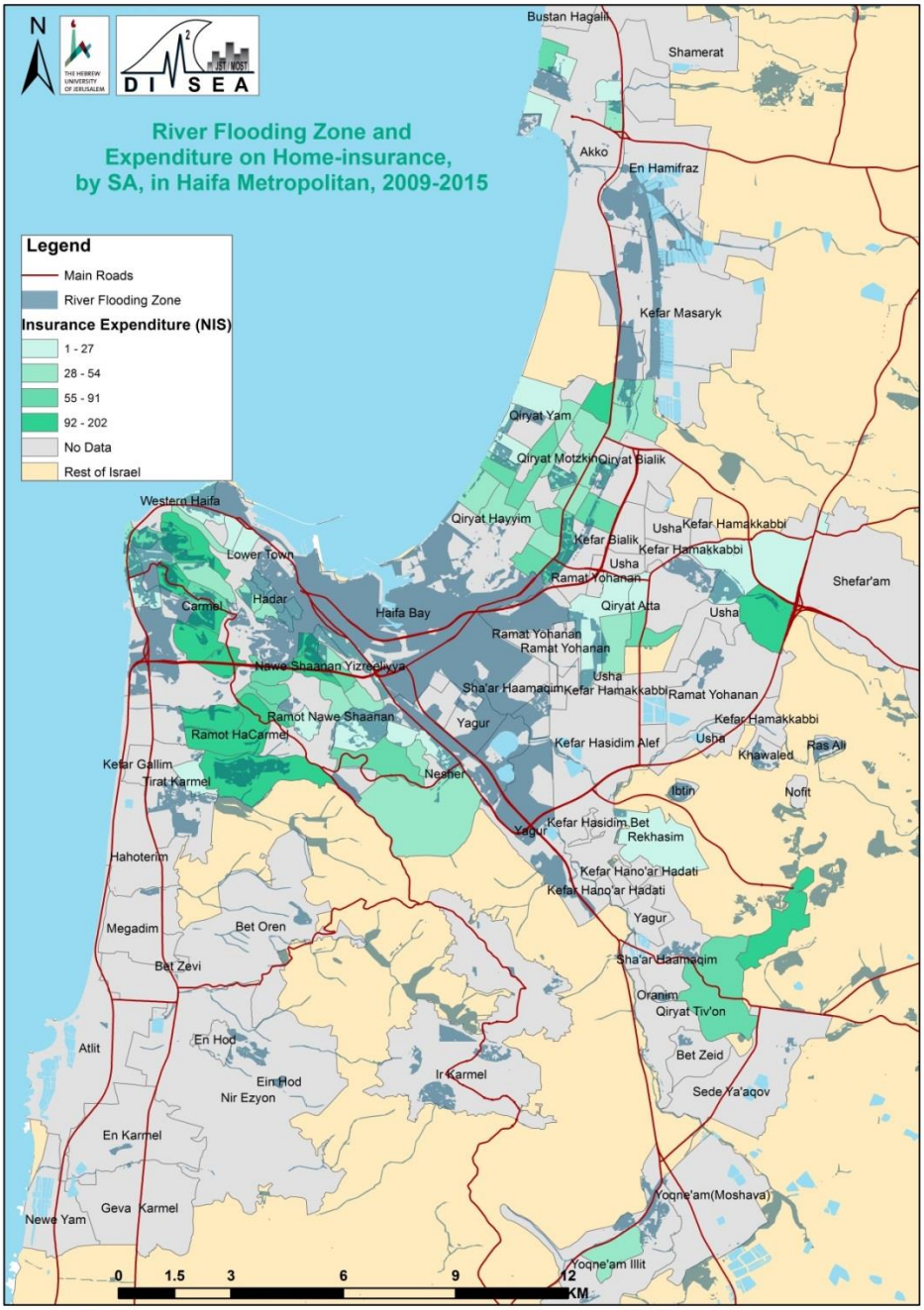
Map 7



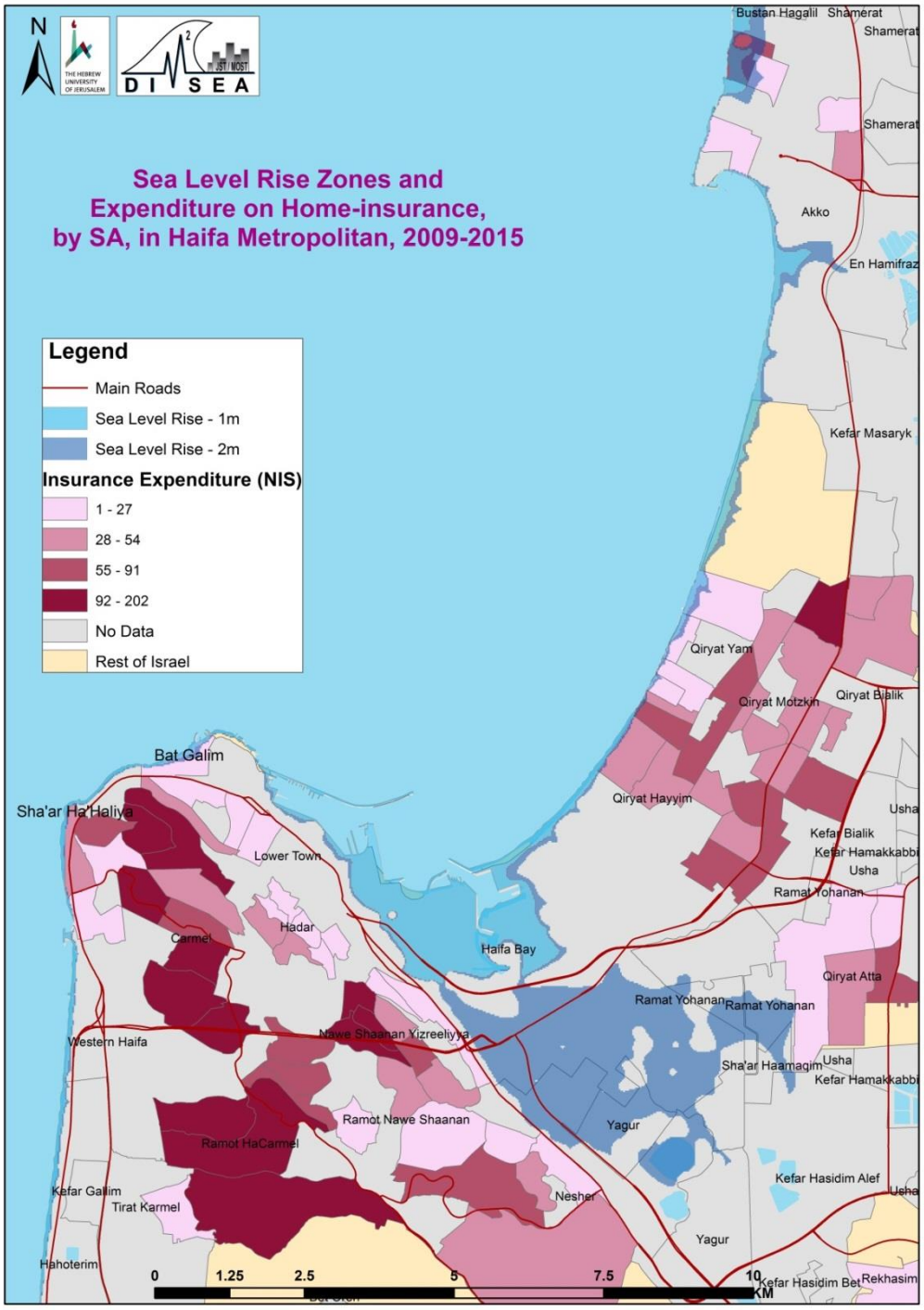
Map 8


N
THE HEBREW UNIVERSITY OF JERUSALEM
DISEA
Combustible Vegetation and
Expenditure on Home-insurance,
by SA, in Haifa Metropolitan, 2009-2015
Legend
Main Roads
Combustible Vegetation
Insurance Expenditure (NIS)
1 - 27
28 - 54
55 - 91
92 - 202
No Data
Rest of Israel
Bustan Hagalil
Shamerat
Akko
En Hamifraz
Kefar Masaryk
Qiryat Yam
Qiryat Motzkin
Qiryat Bialik
Qiryat Hayyim
Kefar Bialik
Usha
Kefar Hamakkabbi
Ramat Yohanan
Shefar'am
Western Haifa
Lower Town
Hadar
Carmel
Haifa Bay
Qiryat Atta
Nawe Shaanan Yizreeliyya
Sha'ar HaamaqimKefar Hamakkabbi
Ramot Nawe Shaanan
Ramot HaCarmel
Yagur
Kefar Hasidim Alef
Khawaled
Ras Ali
Kefar Gallim
Tirat Karmel
Nesher
Ibtin
Nofit
Kefar Hasidim Bet
Rekhasim
Hahoterim
Kefar Hano'ar Hadati
Megadim
Bet Oren
Bet Zevi
Sha'ar Haamaqim
Oranim
Qiryat Tiv'on
Atlit
En Hod
Nir Ezyon
Ir Karmel
Bet Zeid
Sede Ya'aqov
En Karmel
0 1.25 2.5 5 7.5 10
KM

Map 9


N
DISEA
River Flooding Zone and
Expenditure on Home-insurance,
by SA, in Haifa Metropolitan, 2009-2015
Legend
Main Roads
River Flooding Zone
Insurance Expenditure (NIS)
1 - 27
28 - 54
55 - 91
92 - 202
No Data
Rest of Israel
Bustan Hagalil
Shamerat
Akko
En Hamifraz
Kefar Masaryk
Qiryat Yam
Qiryat Motzkin
Qiryat Bialik
Western Haifa
Qiryat Hayyim
Usha
Kefar Hamakkabbi
Kefar Bialik
Lower Town
Ramat Yohanan
Shefar'am
Hadar
Carmel
Haifa Bay
Qiryat Atta
Ramat Yohanan
Nawe Shaanan
Yizreeliyya
Sha'ar Haamaqim
Ramot Nawe Shaanan
Yagur
Ramot HaCarmel
Kefar Hasidim Alef
Khawaled
Ras Ali
Kefar Gallim
Tirat Karmel
Nesher
Ibtin
Nofit
Kefar Hasidim Bet
Rekhasim
Hahoterim
Kefar Hano'ar Hadati
Megadim
Bet Oren
Bet Zevi
Oranim
Qiryat Tiv'on
Atlit
En Hod
Bet Zeid
Ein Hod
Ir Karmel
Nir Ezyon
Sede Ya'aqov
En Karmel
Yoqne'am(Moshava)
Newe Yam
Geva Karmel
Yoqne'am Illit
0
1.5
3
6
9
12
KM

Map 10


N
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DI SEA
JST / MOST
Sea Level Rise Zones and
Expenditure on Home-insurance,
by SA, in Haifa Metropolitan, 2009-2015
Legend
Main Roads
Sea Level Rise - 1m
Sea Level Rise - 2m
Insurance Expenditure (NIS)
1 - 27
28 - 54
55 - 91
92 - 202
No Data
Rest of Israel
Bustan Hagalil
Shamerat
Akko
En Hamifraz
Kefar Masaryk
Qiryat Yam
Qiryat Motzkin
Qiryat Bialik
Bat Galim
Sha'ar Ha'Haliya
Qiryat Hayyim
Usha
Kefar Bialik
Kefar Hamakkabbi
Lower Town
Ramat Yohanan
Hadar
Carmel
Haifa Bay
Qiryat Atta
Ramat Yohanan
Western Haifa
Nawe Shaanan Yizreeliyya
Sha'ar Haamaqim
Ramot Nawe Shaanan
Yagur
Ramot HaCarmel
Kefar Hasidim Alef
Kefar Galim
Tirat Karmel
Nesher
Hahoterim
Kefar Hasidim Bet
Rekhasim
0
1.25
2.5
5
7.5
10
KM

6. Conclusions

We have made the case that property insurance is an important ingredient of household resilience. This is because so much of household wealth is bound up in property. The ability to recover from property loss or damage is therefore determined by household preference for insurance. Looking at behavior in this market also provides the 'missing link' that ties together the economic and social conceptions of 'resilience'.

A simple model is presented that depicts how household preference for insurance can ultimately contribute to community resilience. Empirical evidence on the demand for insurance suggests that personal attributes such as age, income (wealth) and education affect household insurance behavior. Additionally, physical and place-specific features such as location and topography also need to be included. The expected change in wealth (loss) due to the hazard determines the minimum expected level of coverage in a given location. Community resilience is defined as the sum of the marginal changes in wealth with respect to a hazard in relation to some minimum pre-defined level of resilience.

Using empirical data for our case study area, we investigate some of these claims. We map household insurance, intersect spatial patterns of insurance coverage with existing hazards zones and hypothesize the determinants of household behavior with respect to insurance coverage. All this is done at the aggregate (SA) level and relates to the average relationship between household preferences and social and economic factors. A more exhaustive study of household preferences needs to use micro–data. On the basis of this we will be able to test for the impacts of socio-psychological factors such as misperception of risk, spatial herd-like behavior, lack of accurate information and so on. The next stage of this study will be address these issues.

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