Better Together?
Wetlands, Parks and Housing Prices in Auckland

Mario Andres Fernandez

November 2020 Technical Report 2020/025

Research and Evaluation Unit | RIMU

Auckland Council
Te Kaunihera o Tāmaki Makaurau

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Executive summary

Wetlands may be broadly categorised as natural or artificial (e.g. stormwater). Natural wetlands are ecosystem features that provide amenities such as biodiversity, flood control or water purification, though they also imply disamenities such as insects or limits on development. Artificial wetlands are a type of built infrastructure that mimic the natural on serving the purposes of stormwater collection or flood control. Urban planning defines the dimension and location of built infrastructure and open spaces across Auckland. Wetlands and parks affect the shape of the city, which is incorporated by households when making housing purchase and relocation decisions and, consequently, prices.

This study uses hedonic prices (HP) models to investigate how wetlands affect residential property prices in the Auckland region. The HP models rely on market transactions for differentiated houses to determine the implied value of each of the housing characteristics and other environmental amenities affecting prices.

Nonetheless, the arising empirical challenge is the spatial overlap of wetlands and parks, resulting in a bundle of features. This is not trivial because the net benefit to households of the bundle may differ substantially due to size, configuration, house location, landscaping and even market segments. Most importantly, wetlands and parks separately may have either positive or negative effects on prices. Thus, when bundled, effects may cancel out resulting in statistically insignificant estimates. That is, results interpretation may mislead to the conclusion that parks or wetlands have no effect on prices. Hence, the models in this report differentiate between two types of wetlands (natural and artificial), and their spatial intersections with parks. Rather than considering a single homogenous good, wetlands and parks are represented as combinations of multiple goods and services to estimate the marginal value of proximity.

Results reveal a non-linear price premium for every kilometre a house is closer to an artificial wetland intersected with a park. For the case of natural wetlands, an increase of 1000 square metres (within a 300 metre radius around each dwelling) leads to a price decrease of 0.07 per cent. But with a greater scale (a radius of 600 metres) the same increase of natural wetlands leads to a price premium of 0.12 per cent. That is, natural wetlands have a net positive value on housing prices.

This report informs asset management strategies, about the contribution of artificial wetlands (inside parks) to Auckland's urban shape, and conservation efforts about natural wetlands.

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1.0 Introduction

Urban planning defines the dimension and location of built infrastructure and open spaces across any city. In the last decade there has been a shift towards integrating concepts such as green infrastructure, ecosystem services, and nature-based solutions in urban planning practices aimed at enhancing ecosystem services and their amenity values (Cortinovis & Geneletti, 2019; Fernandez & Martin, 2020; Kuminoff, 2009). In the case of Auckland, wetlands and parks are features of the city’s shape, character and ecological infrastructure.

Wetlands provide numerous ecosystem services such as habitat for wildlife; flood protection; water quality improvement; opportunities for recreation, education, and research; buffering against noise and pollution; and aesthetics. But they may also generate disamenities including nuisance animals, insects, odours, or limited mobility across the terrain (Bin & Polasky, 2005; Doss & Taff, 1996; Du & Huang, 2018; Martins-Filho & Bin, 2005; Mei et al., 2018). Wetlands in Auckland consist mainly of natural features protected for conservation purposes or artificial wetlands that channel ecosystem services to benefit the urban population. Artificial wetlands use the natural soil, organisms, and vegetation as a form of water treatment, and act as a filter to remove excessive nutrients, pollutants and sediment loadings. Compared to traditional grey infrastructure, artificial wetlands may deliver water quality improvements with smaller lifetime operational and maintenance costs (Díaz et al., 2012; Irwin et al., 2018; Tournebize et al., 2017). As a component of green infrastructure, they can boost infrastructure system resilience due to their adaptive and regenerative capacity, and multifunctionality by generating numerous positive environmental impacts (Browder et al., 2019).

Parks provide recreational services to improve the liveability of neighbourhoods. Both wetlands and parks have characteristics of public goods whose benefits and costs are shared by many people. As features that shape the urban form of the city, they are incorporated in households purchase and relocation decisions and, consequently, housing prices. That is, households may prefer to live close to (or far from) wetlands conditional to services and amenities they provide (Doss & Taff, 1996). Furthermore, 12 per cent of artificial and 25 per cent of natural wetlands overlap with parks. This is not a trivial issue because the net benefit of the wetland/park bundle on prices may differ due to size, configuration, house location, landscaping and even market segments (Abbott & Klaiber, 2010b).

Economic literature reports that wetlands may have either positive (Mahan et al., 2000; Martins-Filho & Bin, 2005; Tapsuwan et al., 2009b), or negative effects (Netusil, 2013) on housing prices. While the effects of parks on Auckland housing prices have been investigated (Allpress et al., 2016; Fernandez & Bucaram, 2019), it remains uncertain whether wetlands, in interaction with parks, generate positive or negative net benefits (Bin & Polasky, 2005; Doss & Taff, 1996; Martins-Filho & Bin, 2005). Net benefits are also context-dependent. For example, natural open spaces (e.g. ecological areas) in Auckland imply price discounts for houses below the median price, but premiums for upper-end houses. These differing effects may occur because of trade-offs between land use limitations and other regulations seeking to protect amenities and ecosystem services. Also, parks may not add value to houses because of disamenities such as congestion, noise or crime. In fact, neighbourhood parks in Auckland add a premium only for houses in the lower end of the price distribution whereas discounts occur for houses with prices around the median. However, for houses above the median price, parks with any volcanic feature should add to the price premium (Fernandez & Bucaram, 2019)

Therefore, investigating whether parks and wetlands add value to housing prices may reveal their economic contribution as well as inform decisions on the management of assets of local governments and conservation efforts. This technical report then estimates hedonic prices (HP) models to disentangle the effects of wetlands and parks on housing prices in Auckland.

We rely on a dataset of house sales in the Auckland region between 2010 and 2018. The models incorporate two types of wetlands, natural and artificial, and indicate whether they overlap with parks. Rather than considering a single homogenous good, wetlands and parks are represented as combinations of multiple goods and services to estimate the marginal value of proximity (Tapsuwan & Polyakov, 2016). Thus, qualitatively distinct forms of open space and wetlands are introduced in the utility specification to impart utility to households in potentially distinct ways at different scales (Abbott & Klaiber, 2010b; Czembrowski & Kronenberg, 2016a; Gómez-Baggethun & Barton, 2013; Sander & Haight, 2012; Tyrväinen, 1997). The HP models are consistent with the idea that an individual household's marginal utility from open space may be positive or negative, depending on the composition of the bundle of amenities conveyed by the proximity of its house to nearby wetlands and parks (Kuminoff, 2009). From a policy or management perspective, the HP framework examines potential interactions with potentially substitutable or complementary land uses (Abbott & Klaiber, 2010b).

The HP entails regressing housing prices on the distance to the nearest wetland, park and any of their interactions (e.g. artificial wetlands inside/outside parks, natural wetlands inside/outside parks), while controlling for other housing and location-specific characteristics. Output consists of estimates of the marginal price that households implicitly pay for access to either of those features (Kuminoff, 2009; Rajapaksa et al., 2017; Rehm et al., 2018). Additional econometric specifications include the area of wetlands or parks in the surrounding areas around each house for radii of 300, 600 and 1000m. The output complements the proximity results and reveals patterns of wetlands and parks contributing to the 'niceness' or character of neighbourhoods or areas not adjacent to houses.

Results suggest that parks and wetlands in Auckland operate as a bundled amenity. Artificial wetlands inside parks have a destination aspect as proximity implies a positive effect on house prices. Natural wetlands have a differing effect depending on the area of interest. They may imply a price discount if located in the immediacy of a house (a radius of 300 metres), but a price premium for larger areas (600 metres) that represent the "niceness" or character of the neighbourhood. Thus, the net effect of natural wetlands on housing prices is positive. Hence, results in this report are policy-relevant as they reveal how urban households value wetlands, which provide considerations for urban planning and place more emphasis on protecting and improving wetlands (Mei et al., 2018).

This report is structured as follows: Section 2 describes the HP model, econometric specifications and data used; Sections 3 presents and discusses the estimation results; Section 4 concludes.

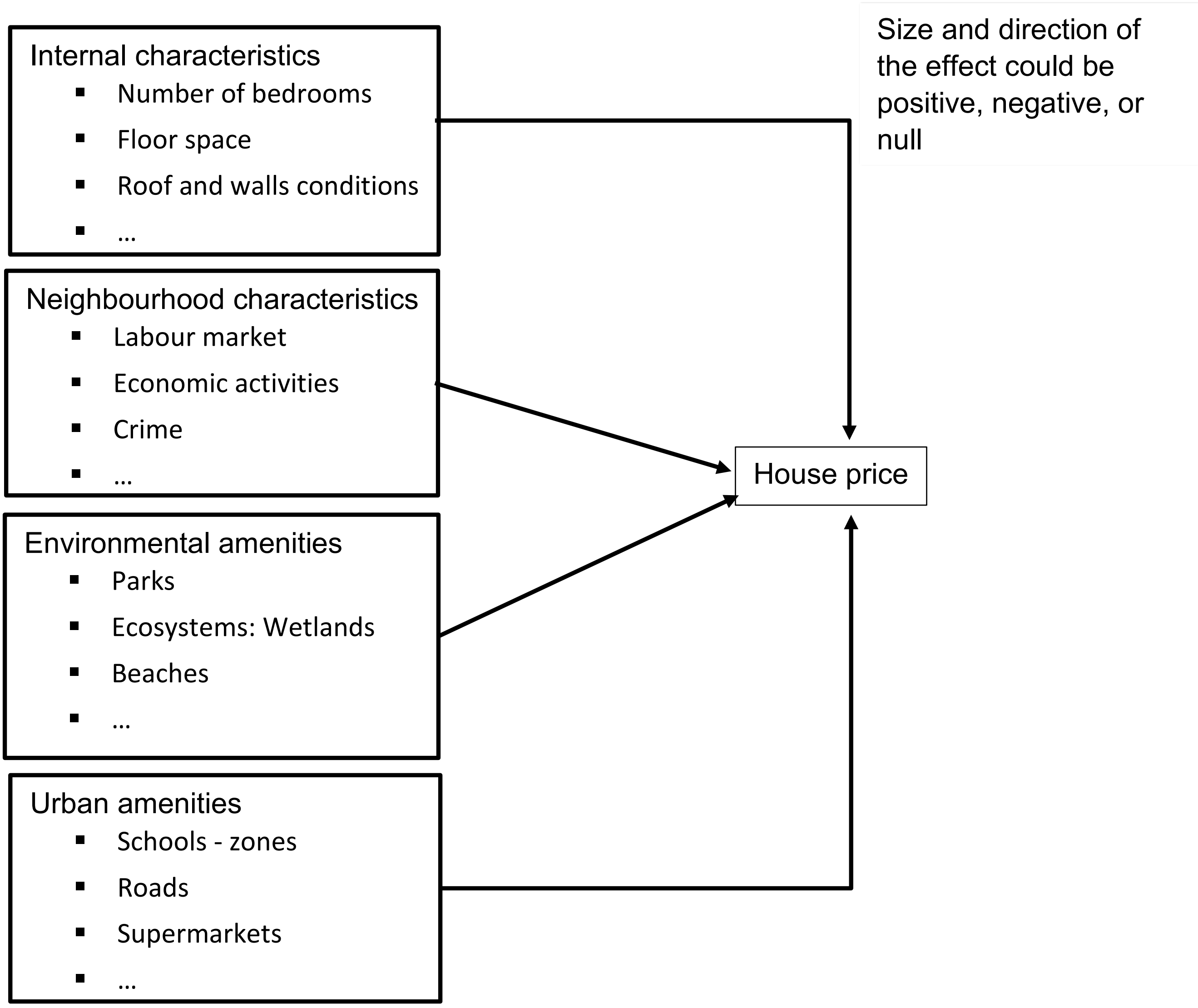
2.0 Method

2.1 The Hedonic Prices Model

The HP model estimates the contribution of the constituent characteristics of a house toward the market price. Characteristics may consist of internal features of the house and land, neighbourhood-level variables, and other non-market variables such as environmental amenities or disamenities (Figure 1). For instance, by observing the price differential between two houses that vary only by one characteristic (e.g. distance to a park), we indirectly observe the monetary trade-offs households are willing to make with respect to the changes in this characteristic, where the increase in amenities value is the difference in the prices of the two houses (Taylor, 2013).

The HP model disentangles a bundle of housing characteristics and, using regression analysis, estimates a marginal effect of each characteristic on the housing price (Cohen et al., 2015). The HP model then measures the preferences towards housing or neighbourhood attributes that cannot be sold separately, some of which are not sold at all in the market (e.g. neighbourhood character, proximity to a city centre, or the recreational aspects of the nearby green space) (Baranzini et al., 2008; Czembrowski & Kronenberg, 2016b). The HP model relies on the assumptions that homebuyers are able to perceive changes in environmental quality potentially affecting housing prices, and therefore they are willing to pay for improvements on quality or to avoid degradations (Bateman, 1993; Kolbe & Wüstemann, 2014). Thus, the HP model can be used to value wetlands as prices of properties near wetlands should contain a capitalised amenity value for wetland proximity. When the houses are sold, the new buyers have to pay for this amenity value in the form of higher house prices (Tapsuwan et al., 2009b). However, this may not always be the case as wetlands and parks may also be the source of disamenities affecting the desirability of houses nearby.

Figure 1: Representation of the Hedonic Prices Model



Research on wetlands and parks is extensive. Mahan et al., (2000) finds that in Portland, Oregon, decreasing the distance to wetlands by 1000 feet raises prices by US$436. Tapsuwan et al., (2009a) find in Perth, Australia, that moving 1m closer to a wetland increases housing prices by AU$42.40. Martins-Filho & Bin (2005) find also for Portland, Oregon, that moving a dwelling adjacent to a wetland two kilometres away produces a decrease in price of about US$20,000. Du & Huang (2018) find in Hangzhou, China, that increasing the proximity to an urban wetland by 1km increases housing prices by 195 yuan per square metre. McFarlane et al., (2009) find in Perth, Australia, that wetlands add about AU$54m to land prices and would add more than AU$24m to the sale price of proposed nearby land if they contain water. Gibbons et al., (2014) find in England that a one percentage point increase in the share of ward land on freshwater, wetlands and flood plain locations adds a premium of 0.36 per cent. Doss & Taff (1996) differentiate by wetland types in Ramsey County, Minnesota, and find that moving an additional 10 metres towards an emergent-vegetation wetland increases house price by $136, towards open-water wetlands by $99, and towards scrub-shrub wetlands by $14. Mei et al., (2018) find that preferences of urban residents in Franklin County, Ohio, for wetland size and proximity to the nearest wetland exhibit an inverted U shape.

Also, Bin & Polasky (2005) find in Carteret County, North Carolina, that housing prices decrease relative to a higher wetland percentage within a quarter mile of a property, proximity to the nearest wetland, and larger size of the nearest wetland. Liu et al., (2020) find for Wuhan, China, that proximity to a wetland when the distance from wetland is greater than 176m may raise housing prices, while proximity to wetland when the distance from wetland is less than 176m may reduce housing prices. Cohen et al., (2015) find for Barkhamsted, Connecticut, no significant effect from wetlands on prices. Nonetheless, they argue that positive and negative effects cancel out as wetlands are a disamenity (possibly due to development restrictions and/or flooding potential) for some houses, while they are an amenity (possibly due to recreational value or aesthetics) for other houses. Fernandez & Bucaram (2019) find a similar result for wetlands in Auckland.

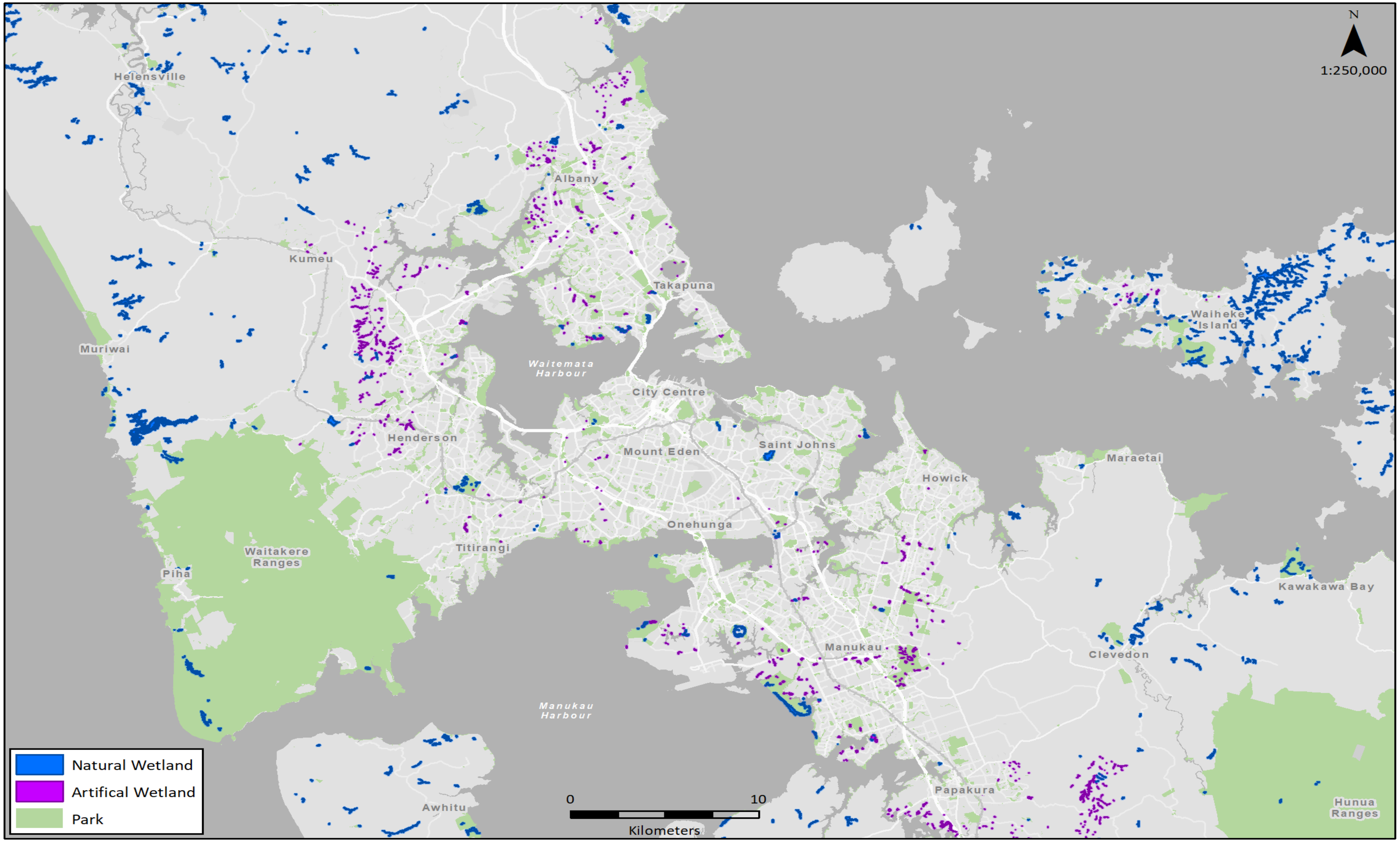
A standard HP equation is a model of the following form:

$$\log(Price) = \alpha + \sum_i \beta_i h_i + \sum_j \gamma_j N_j + \sum_k \phi_k Distances_k + \sum_k \theta_k Sizes_k + \epsilon \qquad (1)$$

where $\log(Price)$ is the log of sales price; h_j is a vector of housing characteristics (e.g. parcel area, floor space), N_j is a vector of neighbourhood characteristics, and $Distances_k$ contains distances (in kilometres) between each house to the edge of the nearest urban (e.g. CBD) and environmental amenities (e.g. wetlands, beaches). For the latter, distances represent a proxy for exposure to the associated ecosystem services of amenities (Brasington & Hite, 2005; Won Kim et al., 2003). Squared terms for all the distance-variables are also included to capture non-linearities and the expected declining effect of distances on house prices. $Sizes_k$ correspond to the size (in square kilometres) of the nearest amenity as an indirect mechanism to add value in the housing price (Fan et al., 2016; Fernandez & Bucaram, 2019).

Figure 2 is a map of Auckland showing both artificial and natural wetlands as well as parks. It is noticeable that there is significant spatial overlap between wetlands and parks.

Figure 2: Distribution of (artificial and natural) wetlands and parks in Auckland

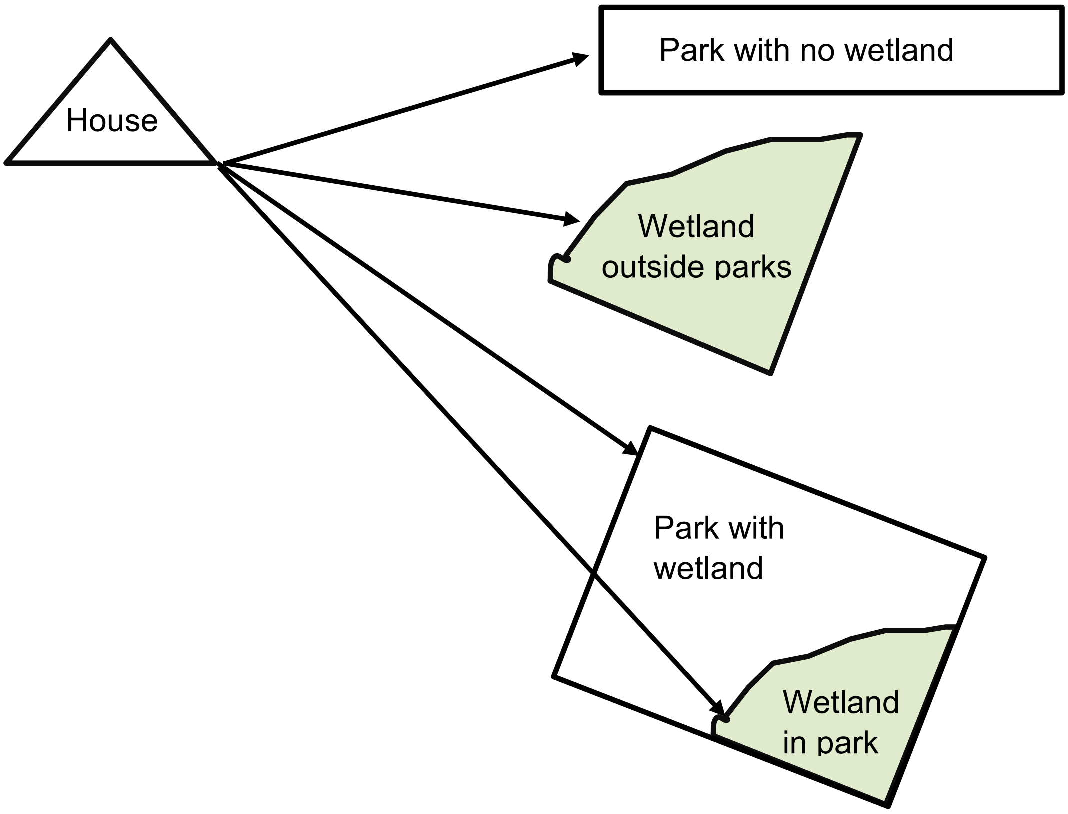


The potential effect on the estimates of Equation 1 is that the bundling of wetlands and parks results in positive and negative effects cancelling out as, for example, wetlands being an amenity (possibly due to recreational value or aesthetics) and parks being a disamenity (possibly due to congestion or noise) (Cohen et al., 2015; Fernandez & Bucaram, 2019). Thus, to address potential bundling, the model distinguishes between (artificial and natural) wetlands inside or outside parks, and parks with or without wetlands inside (panel A of Figure 3). This approach differentiates between qualitatively distinct forms of amenities in the utility specification (Abbott & Klaiber, 2010b) and is specified as follows:

$$\log(Price) = \alpha + \sum_i \beta_i h_i + \sum_j \gamma_j N_j + \sum_g \eta_g Parks_g + \sum_w \rho_w Wetlands_w + \sum_k \tilde{\phi}_k Distances\ Intersections_k + \sum_k \tilde{\theta}_k Sizes\ Intersections_k + \epsilon \quad (2)$$

$Intersections_k$ comprise the distances and sizes to the nearest of following: (i) the portion of an (artificial or natural) wetland inside a park; and, (ii) the portion of a park with (artificial or natural wetland) inside. $Parks_g$ consists of the distance and size to the nearest park that has no wetland feature inside, and $Wetlands_w$ to the nearest (artificial and natural) wetlands outside parks (panel b of Figure 3).

Figure 3: Distances to nearest park and wetland



Many amenities convey services at the parcel level and may be highly localised and spatially differentiated, varying significantly at the parcel scale. Others may be relatively constant over entire blocks or at larger neighbourhood scales. While the distance variables in Equation (2) capture the destination aspect of amenities, there is an additional dimension about broader spatial scales, such as access to large parks or walking paths, that shape the "niceness" of the neighbourhood (Klaiber et al., 2017). Thus, to capture more than the proximity feature of amenities, we estimate Equation 3 as follows:

$$\log(Price) = \alpha + \sum_i \beta_i h_i + \sum_j \gamma_j N_j + \sum_m \delta_m Buffers_m + \epsilon \qquad (3)$$

$Buffers_m$ represent the total area of parkland and (artificial and natural) wetland within concentric ring buffers around each house. Three overlapping rings of 300, 600 and 1000m are used for calculations, where each bigger ring contains the one inside it. This buffering approach allows us to jointly examine both quantity and proximity of open space, and to span the range of distances commonly discussed in the planning literature as "walkable". These variables can be viewed as capturing the value of an additional square metre at a particular distance for recreational and other high proximity-dependent use. Consequently, they capture the contribution of public space within and around houses to neighbourhood character and other public goods (Abbott & Klaiber, 2010a; Gibbons et al., 2014)

Models are estimated through Ordinary Least Squares (OLS) and including spatial fixed effects at Census Area Unit (AU) level (as a proxy for neighbourhoods) (Statistics New Zealand, 2016). This approach is relatively assumption free about the nature of the unobserved neighbourhood heterogeneity (Abbott & Klaiber, 2011), and reduces the bias from omitted variables in cross section data (Kuminoff et al., 2010). Standard errors are clustered at AU level.

2.2 Data

Several data sources were combined to create the dataset used in this paper. Natural wetlands data was gleaned from the dataset associated with the Ecosystem Guide: Indigenous terrestrial and wetland ecosystems of Auckland (Singers et al., 2017). Artificial/constructed wetlands data were obtained from the GIS and Spatial Database of the Auckland Council. The prices dataset was collected from the Sales and Valuation Dataset of the Auckland Council. Data from these sources are combined to enable the attributes of the nearest wetland and park to be attached to each property sales record along with its structural and neighbourhood attributes (Bin & Polasky, 2005).

Summary statistics are presented in Table 1, corresponding to 163,000 sales records from January 2010 to September 2018. From the original dataset, transactions that were likely to be excluded consist of non-arm's-length sales (identified as below the 1st percentile and above the 99th percentile in price), land sales, and observations with invalid or missing data. Sales data from the Hauraki Gulf islands are also excluded. Month and year fixed effects are included in the regression models as well as structural attributes of houses, including floor size, age of house at the moment of sale, slope, orientation, construction materials of roof and walls, number of car spots for garage under main roof or free standing, and whether the house has a deck.

The dataset also comprises about 2600 artificial wetlands, four square kilometres, across the Auckland region, more than 4000 parks or open areas, and 25 square kilometres of natural wetlands. Figure 2 is a map of Auckland showing both artificial and natural wetlands as well as parks.

Table 1: Summary statistics of the variables

Variable	Mean	Std. Dev.
Sale price	763,243	464,034
Land value	401,646	301,354
Adjacent to open space (Yes:1; No: 0)	0.009	0.096
Distance to any wetland	1.953	0.987
Area wetland	6.326	4.726
Distance to artificial wetland in park	5.878	5.064
Area artificial wetland in park	2,816	5,169
Distance artificial wetland not in park	0.974	0.656
Area artificial wetland not in park	3,182	7,128
Distance park with artificial wetland	0.800	0.546
Area park with artificial wetland	0.160	0.287
Distance natural wetland in park	2.062	1.294
Area natural wetland in park	0.009	0.026
Distance natural wetland not in park	2.826	1.557
Area natural wetland not in park	0.005	0.016
Distance park with wetland	1.881	1.213
Area park with wetland	0.852	4.884
Distance park with no wetland	0.136	0.103
Area park with no wetland	0.070	0.705
Distance park with no wetland	0.134	0.102
Area park with no wetland	6.732	50.865
Buffer 300 m artificial wetlands	0.001	0.002
Buffer 600 m artificial wetlands	0.002	0.007
Buffer 1000 m artificial wetlands	0.007	0.013
Buffer 300 m natural wetlands	0.000	0.002
Buffer 600 m natural wetlands	0.001	0.004
Buffer 1000 m natural wetlands	0.003	0.015
Buffer 300 m park with no wetlands	0.023	0.025
Buffer 600 m park with no wetlands	0.108	0.086
Buffer 1000 m park with no wetlands	0.315	0.191

Notes: all distance variables to nearest feature in kilometres, area variables in square kilometres. Non-arm's length transactions removed, identified as below the 1st percentile and above the 99th percentile in price.

3.0 Estimation results

The estimation results are presented in Table 2 for the relevant wetlands and parks variables. A full set of results is available upon request.

The overarching and consistent effect across the models is the price discount of three per cent for houses being adjacent to any type of open space. This result may be related to the presence of power transmission pylons or other nuisances such as lack of privacy or congestion associated with open spaces.

Results in column (1) correspond to the model in Equation 1 where we do not differentiate between the types of wetlands and their potential overlap with parks. The coefficients on most variables are not statistically significant, that is, amenity and disamenity values of wetlands and parks cancel out. This does not rule out the issues raised by Allpress et al., (2016) about an oversupply of parks in Auckland, or by Fernandez & Bucaram (2019) that segmentation of the housing market nets out any premium or discount from parks.

Model 2 introduces the separation between parks and wetlands and their potential overlaps. Results suggest a non-linear price premium for every kilometre a house is closer to an artificial wetland that is also inside a park (i.e. the premium decreases relative to the distance). For example, assume an average house priced at $780,000 and that is located adjacent to an artificial wetland (that is also inside a park). If the same house were located 500m away, its price would decrease by 1.18 per cent, to about 771,000, and for one located at 2km, by 4.12 per cent, to about 748,000. Results in the model do not show that size of the artificial wetland has a role on prices. However, though proximity to a natural wetland inside a park is not significant, its area is significant as for an additional 1000m^2 of size, price increases by 0.04 per cent. Likewise, proximity to a park without wetlands is not significant, but their size does have a small effect.

Arguably, the results indicate that artificial wetlands inside parks reinforce their ecosystem services with other recreation amenities or that households prefer some buffering area around the artificial wetland (Mei et al., 2018). It may also be the case that these features tend to concentrate in recently developed areas in West and North Auckland.

Model 3 differentiates the values that wetlands may have either in the immediate walkable catchment around any property (in a radius between 300m) or rather on the character or relative "niceness" of broader areas at neighbourhood level. That is, the capitalization of wetlands on the housing market may differ because of its adjacency or relative access to a property, or on their contribution to the character of a neighbourhood beyond the walkable catchment. We find contrasting results[1]: an increase of 1000 square metres of natural wetlands in the immediacy of a house (a radius of 300m) leads to a price decrease of 0.07 per cent; whilst the same area increase in a radius of 600m results in a price premium of 0.12 per cent. That is, natural wetlands imply a net positive value on Auckland's housing market, which justifies conservation efforts from an economic perspective.

Results in this report also agree with the "close but not too close" argument observed for hedonic studies on roads, schools, or train stations (Mei et al., 2018; Netusil, 2013). In other words, households value ecosystem services of natural wetlands to spread over a large scale; though at smaller scales, such as the immediacy of properties, wetlands disamenities may prevail over benefits.

[1] Marginal effects are calculated as $(e^{beta} - 1) * 100$

Table 2: Estimation results of Hedonic Price Functions

	Equation 1		Equation 2		Equation 3	
	β	SE	β	SE	β	SE
Log land value	0.445***	0.018	0.445***	0.017	0.445***	0.018
Distance to beaches	0.000	0.000	0.000	0.000	0.000	0.000
Adjacency to open space (No:0)	-0.028*	0.014	-0.029*	0.014	-0.027*	0.013
Distance nearest park	0.050	0.033				
Distance nearest park - sq	-0.034	0.100				
Area of nearest park	-0.012	0.006				
Distance nearest wetland	0.016	0.013				
Area nearest wetland	0.000	0.001				
Distance nearest wetland - sq	-0.002	0.003				
Distance artificial wetland in park			-0.025***	0.009		
Distance artificial wetland in park - sq			0.002***	0.000		
Area artificial wetland in park			0.000	0.000		
Distance park with artificial wetland			0.016	0.013		
Distance park with artificial wetland - sq			-0.004	0.007		
Area park with artificial wetland			-0.008	0.008		
Distance natural wetland in parks			0.020	0.021		
Distance natural wetland in parks - sq			-0.005	0.004		
Area natural wetland in parks			0.145	0.198		
Distance natural wetland not in parks			-0.010	0.011		
Distance natural wetland not in parks - sq			0.001	0.002		
Area natural wetland not in parks			0.334	0.255		
Distance park with natural wetland			0.013	0.019		
Distance park with natural wetland - sq			-0.002	0.004		
Area park with natural wetland			0.001	0.001		
Distance park without wetland			0.013	0.025		
Distance park without wetland - sq			0.017	0.051		
Area park without wetland			0.000	0.000		

	Equation 1		Equation 2		Equation 3	
	β	SE	β	SE	β	SE
Buffer 300m: Artificial wetland					-1.808	1.449
Buffer 600m: Artificial wetland					0.400	0.547
Buffer 1000m: Artificial wetland					-0.550	0.281
Buffer 300 m: Natural wetlands					-1.501**	0.635
Buffer 600 m: Natural wetlands					0.815**	0.348
Buffer 1000 m: Natural wetlands					-0.331	0.238
Buffer 300 m: Park without wetlands					-0.032	0.017
Buffer 600 m: Park without wetlands					-0.031	0.041
Buffer 1000 m: Park without wetlands					0.106	0.078
Intercept	7.196***	0.282	7.408***	0.247	7.197***	0.227

Notes: *** significant at 1%, ** at 5% and * at 10% . sq stands for squared; 162,893 observations between January 2010 and September 2018 in the Auckland region. Standard errors are clustered at AU level. Vast majority of wetlands intersected with parks are totally inside, thus no distance is calculated relative to the portion of wetlands not intersected.

4.0 Discussion

Wetlands and associated ecosystem services are a public good, but their direct benefit to households may not be known. Ecosystem services are not traded in conventional markets, and even if non-market valuation techniques are applied, their bundling with other urban or environmental features (e.g. parks) complicates the understanding about their overall value to society (Frey et al., 2013).

The contribution of wetlands to urban design depends at least as much on the characteristics of the area being considered as it does on the characteristics of the wetlands. Consequently, the responses of the housing market to wetlands will differ not only between natural and artificial wetlands, but also on their interactions with other urban amenities such as parks (Czembrowski & Kronenberg, 2016a). As urban design in the last decade has highlighted the importance of artificial wetlands or the restoration of natural wetlands on shaping the ecological and grey infrastructure of cities, it is of interest to estimate their economic value. Furthermore, as wetlands compete with other urban amenities for land and funding, construction or restoration efforts require understanding whether households benefit from proximity to wetlands and how ecosystem management can be influenced using policy tools and their design (Fernandez, 2019; Frey et al., 2013; Heal, 2000; Kramer, 2012)

Results in this report suggest that the interaction of artificial wetlands with parks adds value to properties. Also, though natural wetlands may imply price penalties on nearby properties, their amenity value manifests beyond the walkable catchment and lead to price premiums. Thus, there is a net premium on housing prices. Hence, this report provides a means for measuring and comparing the various benefits from wetlands and the costs associated with conservation, construction, or restoration.

Though the HP is capable of capturing interactions between the housing market and environmental quality, its scope may be limited to services or amenities that are actually perceived by households. Other natural wetlands amenities such as biodiversity, or intangibles such as cultural, heritage and existence values may not be reflected on property purchase decisions. Consequently, they may not be measured or captured by the HP model (Evangelio et al., 2019; Gibbons et al., 2014). Nonetheless, results in this report justify and inform decisions for wetland features and values to be protected or their restoration promoted (Government of New Zealand, 2020).

Likewise, as artificial wetlands fall in the scope of strategic asset management of local governments in New Zealand, urban planners need estimates of the effects of built infrastructure to quantify its contribution or impact on city design at neighbourhood levels. Developers may use estimates of wetland values to increase property values and evaluate investment strategies. Such values assist decision-making about allocation of budget resources when faced with competing uses (Chaikumbung et al., 2016).

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