“Using a Choice Experiment to Account for Preference Heterogeneity in Wetland Attributes: The case of Cheimaditida wetland in Greece”

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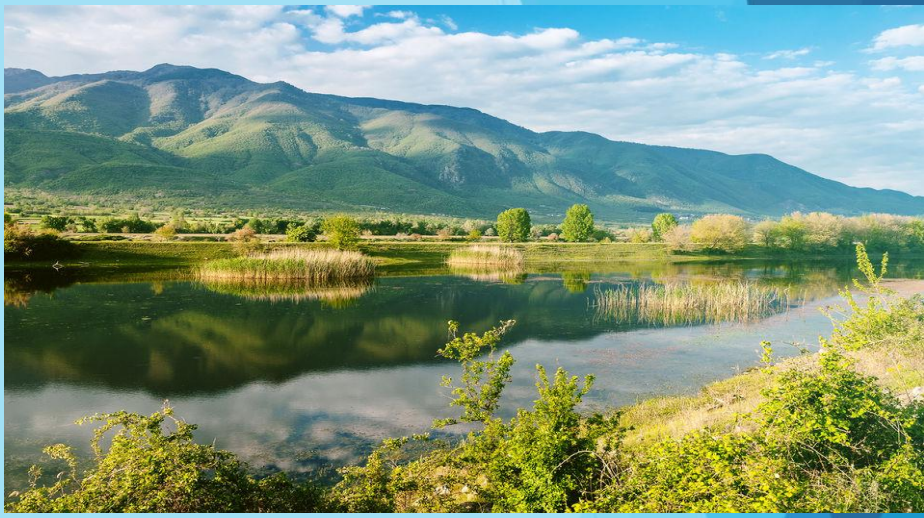
Abstract

- Lake Cheimaditida, Florina
- valuation study
- choice experiment (CE)
- assessment of feature changes
- 407 CE surveys
- 10 cities and towns in Greece
- sustainable management
- significant level of heterogeneity in preferences
- econometric models
- cost-benefit ratios

What is a wetland and why do we study them

- February 2 - World Wetlands Day

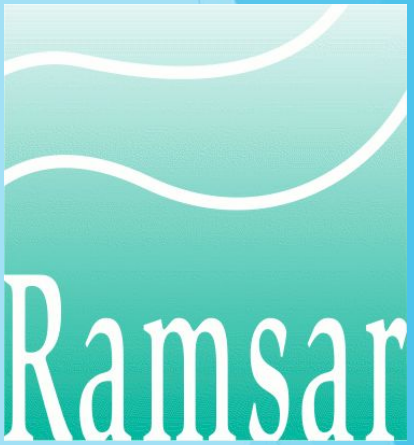


Wetland is any place that is permanently or seasonally covered by shallow water or that is never covered by water but has a wet substrate for a long period of the year. Wetlands are one of the most valuable resources on the planet and second, only to tropical rainforests, in biodiversity and can be natural (estuaries, lakes, rivers, etc.) or artificial (reservoirs, etc.).

- 400 wetlands in Greece
- 10 wetlands have been designated Wetlands of International Importance under the Ramsar Convention

The Ramsar Convention

- was signed in 1971 by 100 countries
- international cooperation
- "conservation and prudent use"
- wetland degradation
- overexploitation of water and irrigation opportunities
- pollution due to runoff from agricultural production and industry



Wetland's value: Cheimaditida wetland

- flood control
- water quality maintenance
- commercial and recreational fisheries
- global climate change mitigation

- freshwater lake
- 6 endangered plant species
- 12 species of plants only in the Mediterranean region
- 11 species of mammals, 7 species of amphibians,
- 7 species of reptiles, 8 species of fish
- "Important Bird Area"

The question

How willing we are to pay for the sustainable conservation of wetlands?

We use econometrics to help us reach the answer.

Choice experiment (CE)

- most modern method of environmental valuation based on research data that can be used to determine the economic value of almost any environmental good or service
- Lancaster theory (1966)
- two or more alternative versions of the environmental good
- statement of preference
- Since one of the characteristics of a good is price, it is possible to determine the availability for payment (WTP) for the levels of the other characteristics of the good.
- is analyzed in 5 steps

First step: identification of the good

Table 1. Wetland management attributes and levels used in the CE

Attribute	Definition	Management levels
Biodiversity	The number of different species of plants, animals, their population levels, the number of different habitats and their size	Low: Deterioration from current levels High: A 10% increase in population and size of habitats.
Open water surface area (OWSA)	The surface area of the lake that remains uncovered by reed beds.	Low: Decrease from the current open water surface area of 20% High: Increase open water surface area to 60%
Research & education	The educational, research and cultural information that may be derived from the existence of the wetland, including visits by scientists, students, and school children to learn about ecology and nature.	Low: Deterioration from the current levels of opportunities High: Improve the level of educational and research opportunities by providing better opportunities by providing better.
Re-training of farmers	Retraining of local farmers in environmentally friendly employment such as eco-tourism and arid-crop production.	Number of farmers re-trained in environmentally friendly employment: 30, 50, 75, 150
Payment	A one-off payment to go to the 'Cheimaditida Wetland Management Fund'.	4 payment levels from the pilot CV: € 3, €10, €40, €80

- identification of services due to resource use
- and population that draws values
- two ecological: biodiversity and open water surface
- two social and economic: research and education, retraining of farmers
- monetary characteristic
- tax increase, "Wetlands Management Fund Heimaditis"
- payment levels: 3 €, 10 €, 40 € and 80 €

Second step: execution process

- telephone, postal survey, interviews
- sample size
- sample composition

In Cheimaditida case:

- personal interviews
- 8 towns (Amynteo, Ptolemaida, Florina, Edessa, Kozani, Veria, Naoussa, Chalkidona) and two cities (Athens and Thessaloniki)
- distance from wetland
- rural and urban population

Third step: questionnaire design

Table 2. Social, economic and attitudinal characteristics of the respondents

Variable	Sample average[a]	Greek average[b]
Heard of the wetland (%heard)	32.7%	-
Visited the wetland (%visited)	19,5%	-
Environmentally consciousness index (ECI) (1-20)	5.3 (3.6)	-
Gender (% female)	49,9%	50,5%
Age	39.2 (14.7)	40.2[c]
Household size	3.2 (1.3)	3.5
Children (% with children)***	51,2%	68%
Number of dependent children in the household	0,8 (0,9)	1.1
Education (% with university degree and above)***	54,3%	18%
Employment (% with full time employment)***	57,6%	46,7%
Tenure (% own property)	78,2%	80%
Income (net, in € per month) ***	1850,6 (1198,4)	1358
Distance from the wetland (in km)	204.2 (194.4)	-
Urban (% located in Athens and Thessaloniki)	46,4%	58%
Sample size, N	407	10,628,123

[a]Source: Cheimaditis Wetland Management Choice Experiment Survey, 2005; [b] Source: National Statistical Service of Greece (NSSG) (2003) www.statistics.gr [c]Median age; T-tests and Pearson Chi square tests show significant differences (*) at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

- initial interviews: groups of population
- initial contacts: general questions
- next contacts: specific questions
- many different options

- social, economic and behavior characteristics of the respondents

- representativeness of the sample, heterogeneity investigation

Fourth step: sample application

- After we have taken care of the proper preparation of the questionnaire and for a representative sample of the population, the questionnaire is shared and the participants answer it.

Fifth step: data collection and processing

Figure 1. Sample choice set

Which of the following wetland management scenarios do you favour? Option A and option B would entail a cost to your household. No payment would be required for "Neither management scenario" option, but the conditions at the wetland would deteriorate to low levels for biodiversity, open water surface area and research and education attributes, and no locals would be re-trained.

	Wetland management Scenario A	Wetland management Scenario B	
Biodiversity	Low	High	Neither management
Open water surface area	Low	Low	scenario A nor
Research and education	High	Low	management scenario B:
Re-training of locals	50	50	
One-off payment	€ 3	€ 10	I prefer NO wetland management
I would prefer:	Choice A	Choice B	

Neither (Please tick as appropriate)

- discrete choice analysis
- real willingness to pay through the successive options between alternatives

- many alternatives
- easier statement preference
- minimize causes of bias

- two management scenario profiles and a status quo

Econometric models

i) Conditional Logit Model.

ii) Random Parameter Logit Model.

iii) Random Parameter Logit Model with Interactions.

iv) Latent Class Model.

Logit regression model

- non-linear
- specially designed for binary dependent variables
- logistic regression

The population logit model of the binary dependent variable Y with many interpretive variables is:

$$Pr(Y=1|X_1,X_2,...,X_k)=F(\beta_0+\beta_1X_1+\beta_2X_2+...+\beta_kX_k)$$

- Lancaster: satisfaction not from the products themselves but from the features they provide
- econometric basis in the theory of random utility (RUT)

Conditional Logit Model (CL)

$$U_{ij}=V(Z_j , S_i) + e(Z_j , S_i) \quad (1)$$

i: participants
j: any alternative wetland management scenario
Z_j: the characteristics of the wetland management scenario
S_i: the social, economic and characteristics of the respondent

CL:

$$P_{ij}=\exp(V(Z_{ij} ,S_i)) / \Sigma_{heC} \exp(V(Z_{ih} ,S_i)) \quad (2)$$

conditional indirect utility function:

$$V_{ij}= \beta+ \beta_1 Z_1+ \beta_2 Z_2+ ...+ \beta_n Z_n+ \delta_1 S_1+ \delta_2 S_2+...+ \delta_l S_m \quad (3)$$

β: the alternative specific fix (ASC) which was set to be 1 when any management scenario A or B is selected, and 0 when "neither management scenario" is selected
n: number of management scenarios
m: number of social, economic and behavioral characteristics of the respondent
β1 to βn are linked to the vector of scenario features Z
δ1 to δl are linked to the vector of interaction terms S

- fixed characteristics of the respondent in different cases of choice, these are introduced only as terms of interaction

Table 3. CL, RPL and RPL with interactions estimates for wetland management attributes

	CL Model	RPL Model		RPL Model with Interactions	
Attributes and interactions	Coefficient (s.e.)	Coefficient (s.e.)	Coeff. Std. (s.e.)	Coefficient (s.e.)	Coeff. Std. (s.e.)
ASC	0.784*** (0.064)	1.748*** (0.509)	2.30*** (0.88)	1.22*** (0.157)	0.098 (0.58)
Biodiversity	0.222*** (0.025)	0.325*** (0.065)	0.069 (0.258)	0.13 (0.11)	0.012 (0.33)
OWSA	0.140*** (0.027)	0.227*** (0.064)	0.707*** (0.262)	-0.08 (0.13)	0.81*** (0.19)
Research & education	0.124*** (0.026)	0.195*** (0.055)	0.462* (0.335)	0.18* (0.13)	0.79** (0.2)
Re-training	0.002*** (0.001)	0.003*** (0.001)	0.012*** (0.005)	-0.2*** (0.004)	0.016*** (0.003)
Payment	-0.014*** (0.001)	-0.021** (0.004)	-	-0.23*** (0.028)	-
Biodiversity * Education	-	-	-	0.055 (0.082)	-
OWSA* Education	-	-	-	0.13* (0.099)	-
Research* Education	-	-	-	0.15* (0.096)	-
Re-training* Education	-	-	-	0.006*** (0.002)	-
Biodiversity*ECI	-	-	-	-0.0015 (0.011)	-
OWSA*ECI	-	-	-	0.051** (0.014)	-
Research*ECI	-	-	-	0.033** (0.013)	-
Re-training *ECI	-	-	-	0.002*** (0.0003)	-
Biodiversity* Income	-	-	-	$0.1x10^{-4}$ ($0.3x10^{-4}$)	-
OWSA*Income	-	-	-	$-0.3x10^{-4}$ ($0.4x10^{-4}$)	-
Research*Income	-	-	-	$0.1x10^{-4}$ ($0.4x10^{-4}$)	-
Re-training Income	-	-	-	$0.3x10^{-5}$** ($0.8x10^{-6}$	-
Biodiversity*Child	-	-	-	0.05 (0.08)	-
OWSA*Child	-	-	-	-0.2** (0.1)	-
Research*Child	-	-	-	-0.04 (0.09)	-
Re-training* Child	-	-	-	-0.004** (0.002)	-
Biodiversity* Visit	-	-	-	0.14* (0.1)	-
OWSA*Visit	-	-	-	-0.07 (0.12)	-
Research*Visit	-	-	-	-0.1 (0.1)	-
Re-training* Visit	-	-	-	0.005** (0.002)	-
Biodiversity* Distance	-	-	-	0.0006*** (0.0002)	-
OWSA*Distance	-	-	-	0.0009*** (0.0003)	-
Research*Distance	-	-	-	0.001*** (0.0003)	-
Re-training* Distance	-	-	-	$0.4x10^{-4}$*** ($0.6x10^{-5}$)	-
Log likelihood	**-3325.697**		**-3316.284**		**2485.16**
ρ^2	**0.0703**		**0.0729**		**0.1191**
Sample size	3256		3256		3256

Random logit model (RPL)

The CL assumes the independence of the non-relative alternative property (IIA), which states that the relative possibilities of two options are not affected by the introduction or elimination of other alternatives. If the IIA property is violated, the CL results will be biased and therefore a discrete selection model that does not require the IIA property, such as the random parameter logit (RPL) model, should be used.

- CL model in this case presupposes homogeneous preferences
- However, preferences are in fact heterogeneous and this heterogeneity allows us to estimate individual preferences accurately and reliably.

$$U_{ij}=V(Z_j, S_i) + e(Z_j, S_i) \quad (1) \Longrightarrow \boxed{U_{ij}=V(Z_j (\beta+n_i), S_i)+ e(Z_j, S_i) \quad (4)}$$

- introduction of parameter β (ASC) to the deterministic element

$$P_{ij}=\exp(V(Z_{ij}, S_i)) / \Sigma_{heC} \exp(V(Z_{ih}, S_i)) \quad (2) \Longrightarrow \boxed{P_{ij}=\exp(V(Z_j(\beta+n_i), S_i)) / \Sigma_{heC} \exp(V(Z_h(\beta+n_i), S_i)) \quad (5)}$$

- joint effect of n_i without bias problems
- RPL model superior to the CL model

Random parameter Logit model with interactions (RPL with interactions)

The RPL model can not explain the sources of heterogeneity and therefore the random parameter logit model with interactions is introduced.

- combination of the four wetland management characteristics with the social, economic and behavioral characteristics of the respondents
- larger overall application compared to the CL and RPL models, with a ρ^2 of 0.12
- positive interactions between: university degree, and ECI and OWSA, research and education opportunities and re-training of locals as well as between income and retraining
- the interaction between having visited the wetland and biodiversity are positive
- the positive interactions between wetland attributes and distance to the wetland are contrary

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Latent class model (LCM)

- more recent model as an alternative model for the accounting heterogeneity of preferences
- in parallel with heterogeneity allows the number of segments of the population to be determined endogenously from the data

Respondent i belongs to the latent part l, and the utility function becomes:

$$U_{ij/l}=V_{ij/l}(Z_{j/l}, S_{i/l}) + e_{ij/l}(Z_{j/l}, S_{i/l}) \quad (6)$$

CL:

$$P_{ij/l}=\exp(V_{ij/l}(Z_{j/l}, S_{i/l})) / \Sigma_{h=1 \text{ to } C} \exp(V_{ih/l}(Z_{h/l}, S_{i/l})) \quad (7)$$

, assuming that respondent i selects management scenario j provided it belongs to a segment l.

Participation probability function:

$$M^*_{il}=\lambda_l S_i+\xi_{il} \quad (A)$$

(7) $\xrightarrow{(A)}$ participation probability in CL: $P_l=\exp(\lambda_l S_i) / \Sigma_{l=1 \text{ to } L} \exp(\lambda_l S_i)$ (8)

where λ_l (l=1, 2, ...,L): participation probability

$0 \le P_l \le 1$

A positive λ indicates that the relative characteristic of the respondent, Si, increases the probability that the respondent i belongs to segment l.

size section: $W_l=\Sigma_i P_l / I \quad (9)$

The possibility of choosing an alternative scenario j:

(7) $\xrightarrow{(8)}$ $P_j=\Sigma_{l=1 \text{ to } L}[(P_j)*(P_{j/l})]$ (10)

The probability of the respondent's choices against the condition of participation in group l=1, 2, ...,L is given by:

$$P_{j1,\ldots,jT/l}=\Pi_{t=1 \text{ to } T}[\exp(\Delta(V_{ijt/l}(Z_{jt/l},S_{it/l})))/\Sigma_{h=1 \text{ to } C}\exp(\Delta(V_{iht/l}(Z_{ht/l},S_{it/l})))] \quad (11)$$

The log-likelihood function:

$LL=\Sigma_i\Sigma_{jeC}I_j \ln\Sigma_l P_l P_{j1,\ldots,jT/l}$ (12) I_j: variable for the selected option of payment

- The latent class model, therefore, assumes that the characteristics of the respondents indirectly influence the choice through the effect they have on the group.

Table 5. Criteria for Determining the Optimal Number of Segments

No. of Segments	Log likelihood	ρ^2	Parameters (P)	AIC	BIC
1	-3325.7	0.07	6	6663.4	3301.44
2	-2538.98	0.29	18	5041.96	2611.50
3	-2428.2	0.321	30	4916.4	2306.88
4	-2423.8	0.322	42	4931.6	2253.95

AIC(Akaike Information Crietrion) is –2(LL-P); BIC(Bayesian Information Criterion) is –LL+(P/2)*ln(N)

- determining the optimal number of segments requires a balanced evaluation of the statistical data
- improvement as more segments are added
- the 2-part solution provides the best fit
- from 1 to 2 segment the difference is greater than from 3 to 4 sections

Table 7. Profiles of respondents belonging to the two segments in LCM

Social and economic characteristics	Segment 1	Τμήμα 2
	N=233	N=174
Heard of the wetland	30.6%	31.2%
Visited the wetland**	13.7%	21.2%
ECI***	7 (3.5)	4.3 (3.2)
Gender***	61.5%	43.3%
Age	38.9 (13.4)	40.2 (15.3)
Household size***	3.6 (1)	2.9 (1.3)
Children***	67.6%	45%
Number of dependents***	1.2 (0.9)	0.6 (0.9)
Education***	88%	32.9%
Employment***	66.4%	57%
Tenure	80%	80.3%
Income***	2701.5 (1319.5)	1470.7 (735.2)
Distance **	193.1 (165.8)	241.2 (225.3)
Urban*	51.8%	46.3%

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005; T-tests and Pearson Chi square tests show significant differences (*) at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

- 57.24% of the sample belongs to the first segment and 42.76% belongs to the second segment
- in segment 1 they have a larger number of dependent children but a shorter distance from the wetland
- this suggests the importance of distance from the wetland

Estimation of willingness to pay

Table 8. Marginal WTP for wetland management attributes (€ / respondent) and 95% C.I

Attributes	CL Model	RPL Model	RPL Model Interactions	Latent Class Model		
				Seg. 1	Seg. 2	Weighted
Biodiversity***	15.62 (13.55-17.69)	15.44 (13.57-17.3)	15.10 (13.10-17.10)	17.8 (16.10-19.5)	-	7.7 (6.96-8.44)
OWSA***	9.86 (7.90-11.82)	10.79 (8.80-12.78)	11.02 (8.94-13.10)	10.01 (8.25-11.88)	7.25 (5.13-9.38)	8.45 (6.48-10.46)
Research & education***	8.69 (6.80-10.58)	9.27 (7.45-11.09)	10.79 (8.76-12.82)	9.1 (7.34-10.84)	-	3.93 (3.17-6.15)
Re-training (per person)***	0.122 (0.078-0.166)	0.129 (0.078-0.18)	0.154 (0.103-0.210)	0.195 (0.149-0.24)	0.075 (0.03-0.12)	0.127 (0.066-0.172)

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005. T-tests show significant differences among at least one pair of models (*) at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

Measuring well-being :

$$WTP = \ln\Sigma_k \exp(V^1{}_k) - \ln\Sigma_k \exp(V^0{}_k) / \beta_{monetaryattribute} \quad (13)$$

WTP: the welfare measure

$\beta_{monetaryattribute}$: the marginal utility of income

$V^0{}_k$, $V^1{}_k$: represent indirect functions before and after the change in wetland management

Simplify equation (13) to equation (15) using compensatory surplus welfare measures:

$$\text{Compensating surplus} = = -(V^0 - V^1) / \beta_{monetaryattribute} \quad (15)$$

- Table 8: indirect and limit WTP values

- **Current Scenario-Status Quo:** - no scenario is chosen
  - biodiversity is managed at a low level
  - the open water surface is low
  - research and educational opportunities are low
  - no local farmer is retrained
- **Scenario 1- or low impact management scenario:** - biodiversity is managed at a low level
  - the open surface area of the water is increasing at a high level
  - research and educational opportunities are low
  - 30 local farmers are being retrained
- **Scenario 2 - or medium impact management scenario:** - biodiversity is managed at a high level
  - the open surface is low
  - research and educational opportunities are high
  - 75 local farmers are being retrained
- **Scenario 3 - High Impact Management Scenario:** - biodiversity is managed at a high level
  - the open surface is high
  - research and educational opportunities are high
  - 150 local farmers are retrained

Table 9. Compensating Surplus for each scenario (€ / respondent)

Scenario	CL Model	RPL Model	RPL Model with Interactions	Latent Class Model		
				Seg.1	Seg.2	Weighted
1- Low impact	83.77	62.24	58.2	170	57.75	107.59
2- Medium impact	103.71	81.87	80.11	195.67	53.88	116.49
3- High impact	122.72	120.43	102.69	220.3	66.75	134.46

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005. T-tests show significant differences (*) at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

Compensatory surplus for each scenario.

- as we move towards improved ecological, social and economic conditions for the wetland, so does the compensatory surplus
- as the weighting in the last column goes up,both go up and the benefits that the public will reap

Table 10. Cost estimates for improvement in wetland management

Management Intervention	Cost in € (2005)[a]
Biodiversity:	
1. Improve water quantity by switching to water-saving irrigation technologies and construction of a dyke.	4,000,000
2. Improve water quality with construction of wastewater treatment plant.	1,000,000
3. Protection, conservation, and restoration of Priority Natural Habitats (92/43/EEC).	25,000
Increase OWSA:	
Open and maintain corridors in the reed bed.	200,000
Research and Education Opportunities:	
1. Construction of a visitor centre	600,000
2. Monthly two-day researcher's bench (collect data/samples, sort and browse)	84,000 /annum
Retraining Farmers:	
1. Two seminars of 100 hrs for beginners, theory and practice	98,000
2. Cost (i.e., farmers profit loss) of switching to non-irrigated crops[b].	1591.2 /ha/annum

Source: Miltos Seferlis, personal communication (EKBY, 2005);[a] These are one-time costs, unless otherwise indicated;[b] This is the difference between gross margin for non-irrigated crops (76.63 €/ha/annum), and gross margin for irrigated crops (1667.78 €/ha/annum).

Cost-benefit ratios

- the total cost of providing the low impact scenario is €500,872 per year
- the total cost of providing the medium impact scenario is €6,314,179 per year
- the total cost of providing the high impact scenario is € 7,021,358 per year

- overall prosperity for the achievement of ecological and social conditions is in the

low impact scenario of €335,852,335

medium impact scenario € 363,735,948

high impact scenario, €419,846,644

- the overall benefits are significantly higher than the total cost of each scenario

Conclusions

- Policy Implications.
- There are positive and significant economic benefits associated with the ecological, economic and social characteristics of the Himaditis wetland.
- It is very important to take into account the heterogeneity of preferences in the Greek public.
- Maximising social well-being is achieved under the high impact scenario of wetland management.

Today: steps for the protection of wetlands internationally such as Freshwater Wetlands Protection Act in USA, IUCN, Conservation Commission Wetlands Rules & Regulations etc

https://rsis.ramsar.org/

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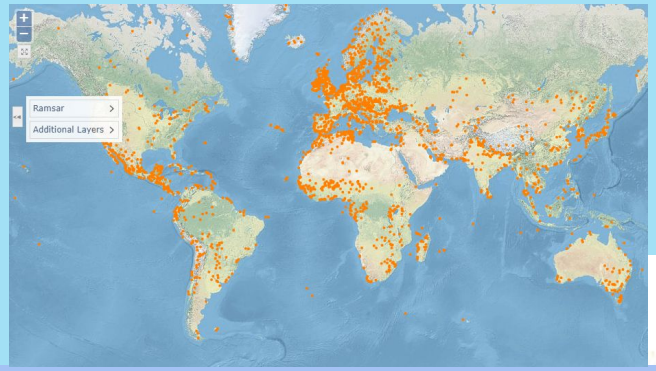
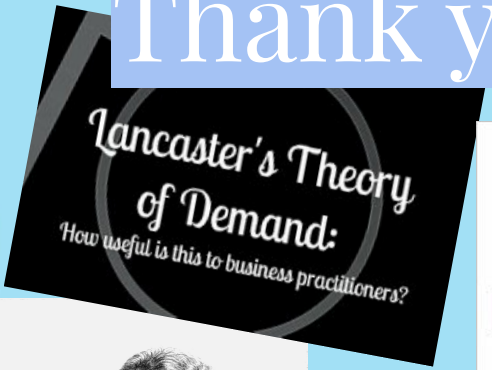
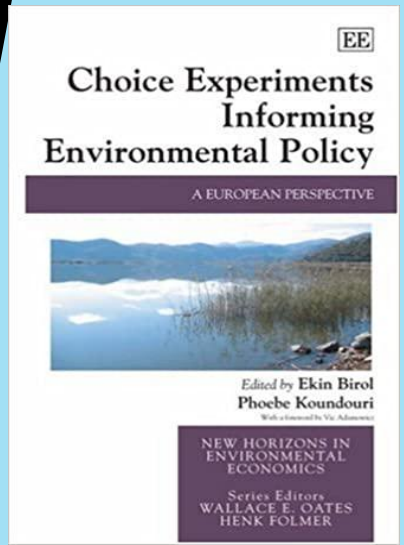


Thank you for your attention!





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