ASSESSING CLIMATE CHANGE IMPACT IN HOSPITALITY SECTOR

SIMPLIFIED APPROACH USING BUILDING RESOURCES CONSUMPTION SIGNATURE

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1 – Introduction: Climate change impact

Climate change impact assessment and the development of adaptation strategies requires the study of vulnerabilities and risk to climate variables.

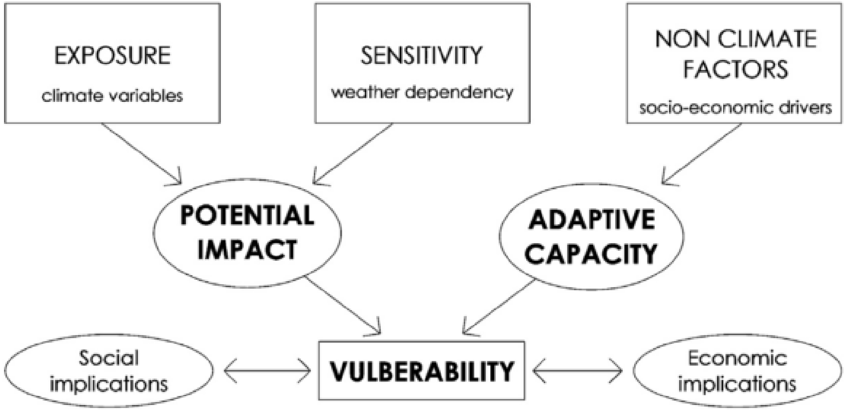
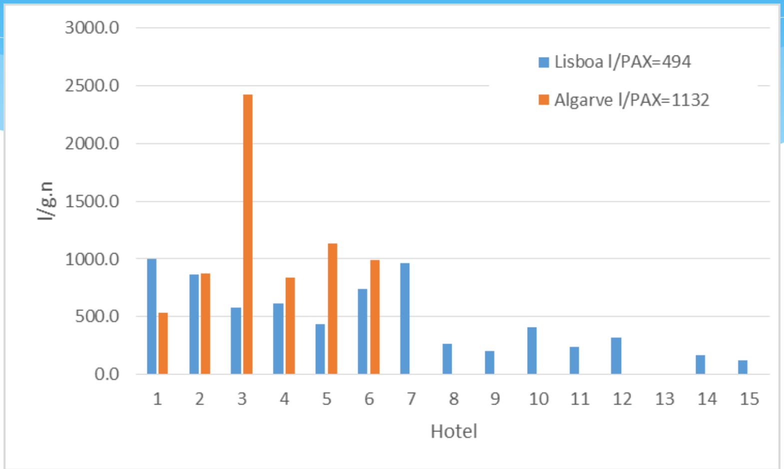


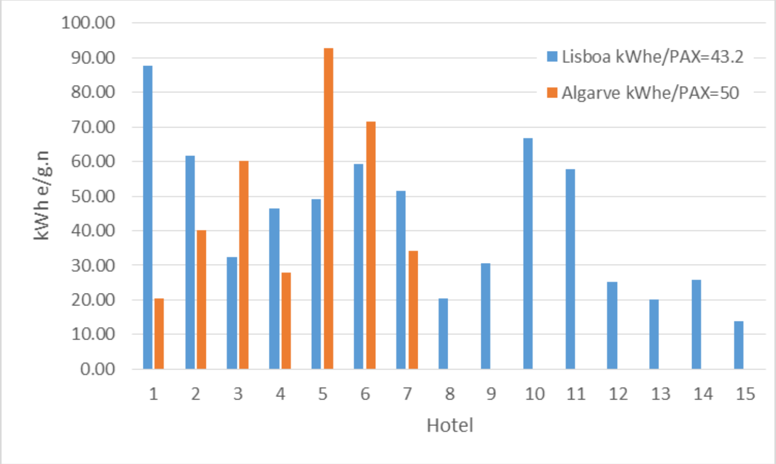
Fig. 2. Climate Impact and Vulnerability Assessment Scheme (CIVAS) methodology [34].

Temperature increase and water stress are critical for hotel service quality and exploration costs.

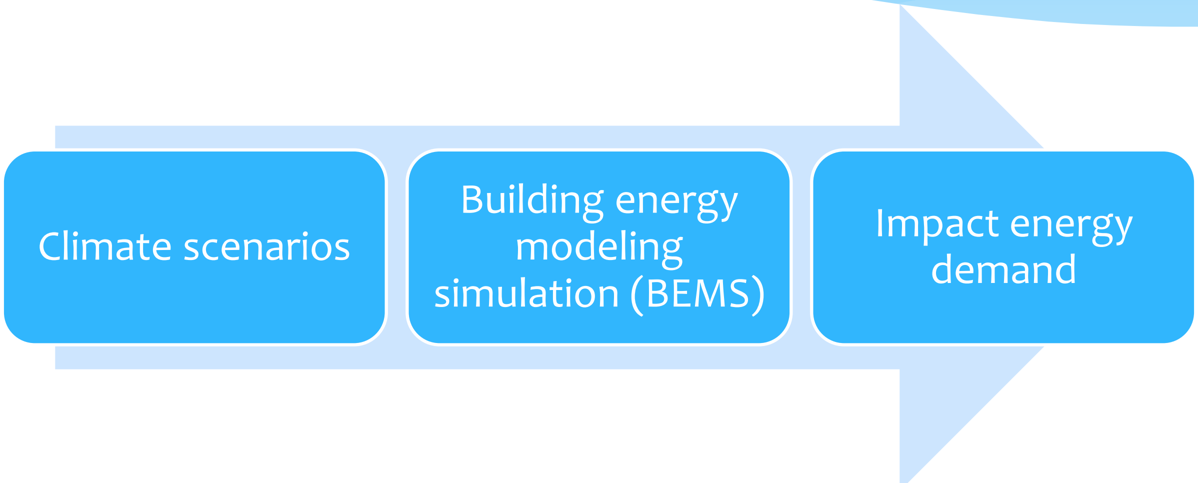
1 – Introduction: Hotels

* Hotels are buildings with high energy and water consumption (dwellings: 100 to 150 l/p/day, 3 to 4 kWh/p/day)
* Hotels are vulnerable to climate, for example:
  * Heat waves: increase energy consumption (cooling and food refrigeration)/compromise comfort
  * Water stress: restriction on use of water, increase water consumption for irrigation of lawns, swimming pools, etc



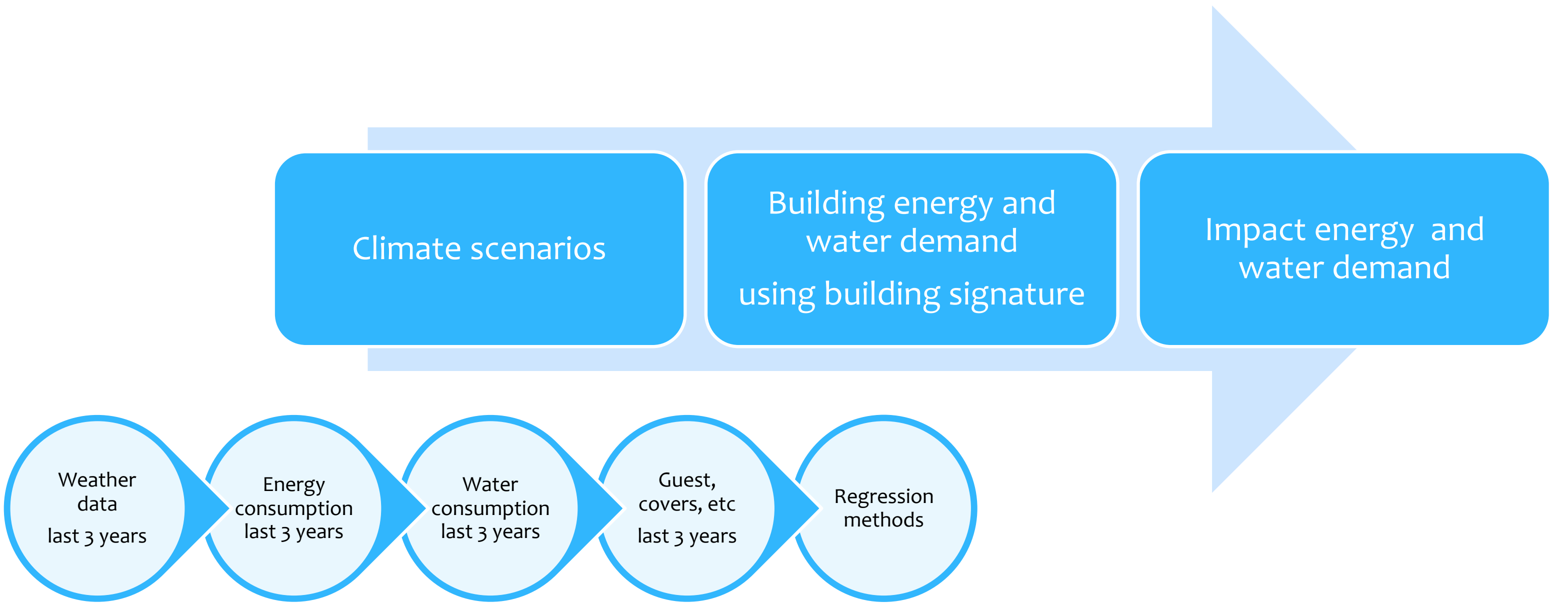


1 – Introduction: Previous Works/ Methodologies



* Greece (Asimakopoulos et al., 2012) BEM, decrease in heating demand by 50% and an increase of 248% in cooling demand.
* Portugal (SIAM II,2006) estimates electricity consumption of 250 to 465 kWh/PAX, CC impact of 30%.

2 – Proposed simplified Methodology



2 – Proposed simplified Methodology

* Use monthly data (limitation: phenomena with dynamics faster than 1 month are neglected)
* Building signature can predict energy consumption of complex buildings (business as usual) with few parameters and low uncertainty
* Regression methods/buildings signature is recognized and used as base line in energy efficiency contracts.

2 – Proposed simplified Methodology

$Gas(kWh)=(Q_{heat}+Q_{hot\ water})/\eta_{boiler}+n_p\ G_{kitchen}$

$$Q_{heat}(kWh)=\sum\left[\sum A.U+\rho\dot{V}c_p\right](T_i-T_o)-\eta(G_{solar}+G_{internal})$$

$$Q_{hot\ water}(kWh)=\sum\rho_w c_{pw} n_p W_p(T_{hot\ w}-T_w)+\sum\rho_w c_{pw} A_{pool} W_{pool}(T_{pool}-T_w)$$

$$\hat{Y}=\beta_0+\beta_1\hat{X}_1+\beta_2\hat{X}_2+\ldots+\beta_p\hat{X}_p$$

$$E(kWh)=a_e+b_e.T+c_e.G$$

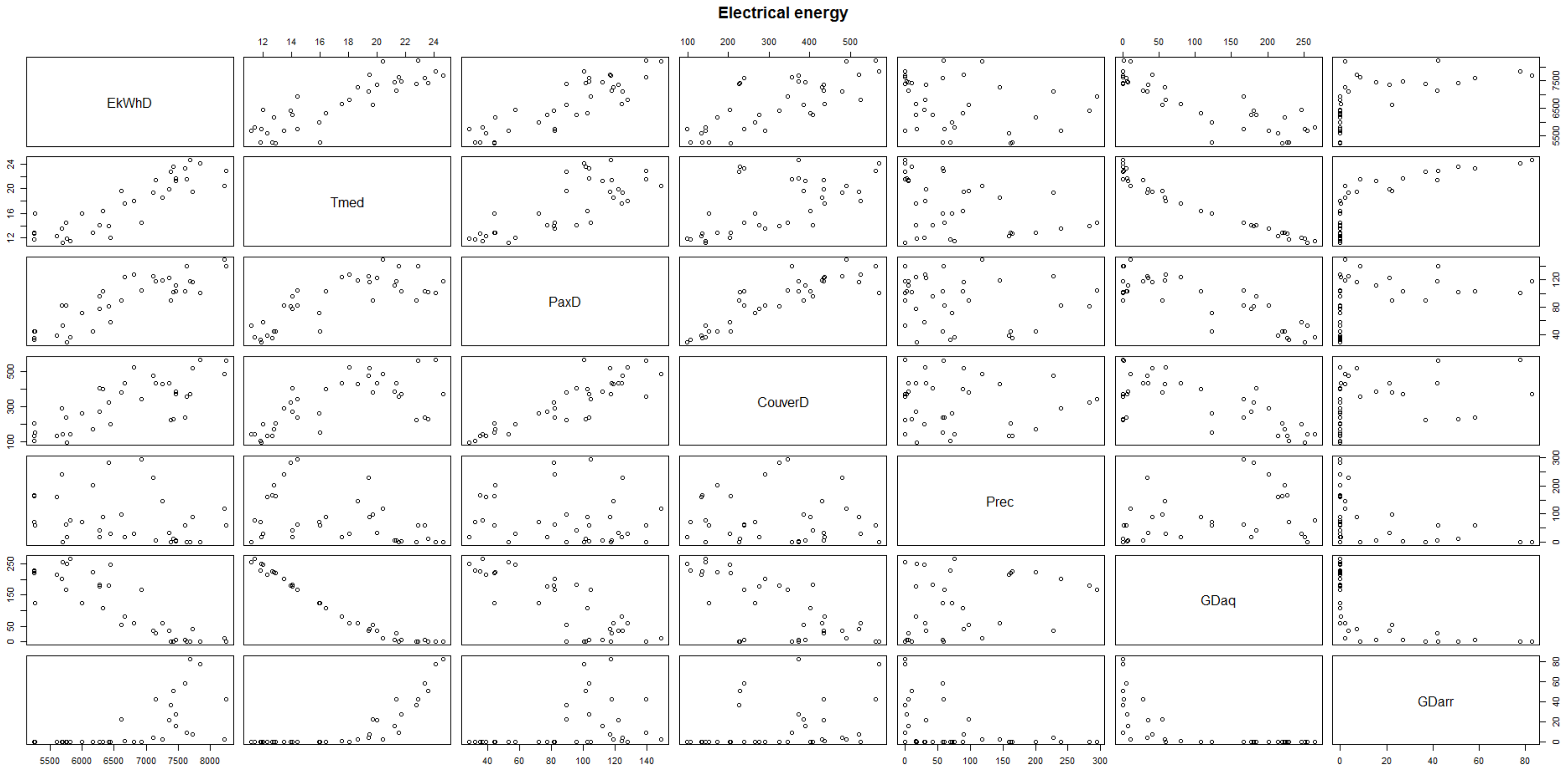
$$G(kWh)=a_g+b_g.T+c_g.G$$

$$W(m^3)=a_w+b_w.T+c_w.G+d_w.P$$

$R^2 \geq 0.75$, p-value $\leq 5\%$

- E – Electricity
- G – Gas
- W – Water
- T – Temperature (outdoors)
- G – Guest/night
- P – Precipitation (rain)
- All values: monthly mean

2 – Proposed simplified Methodology



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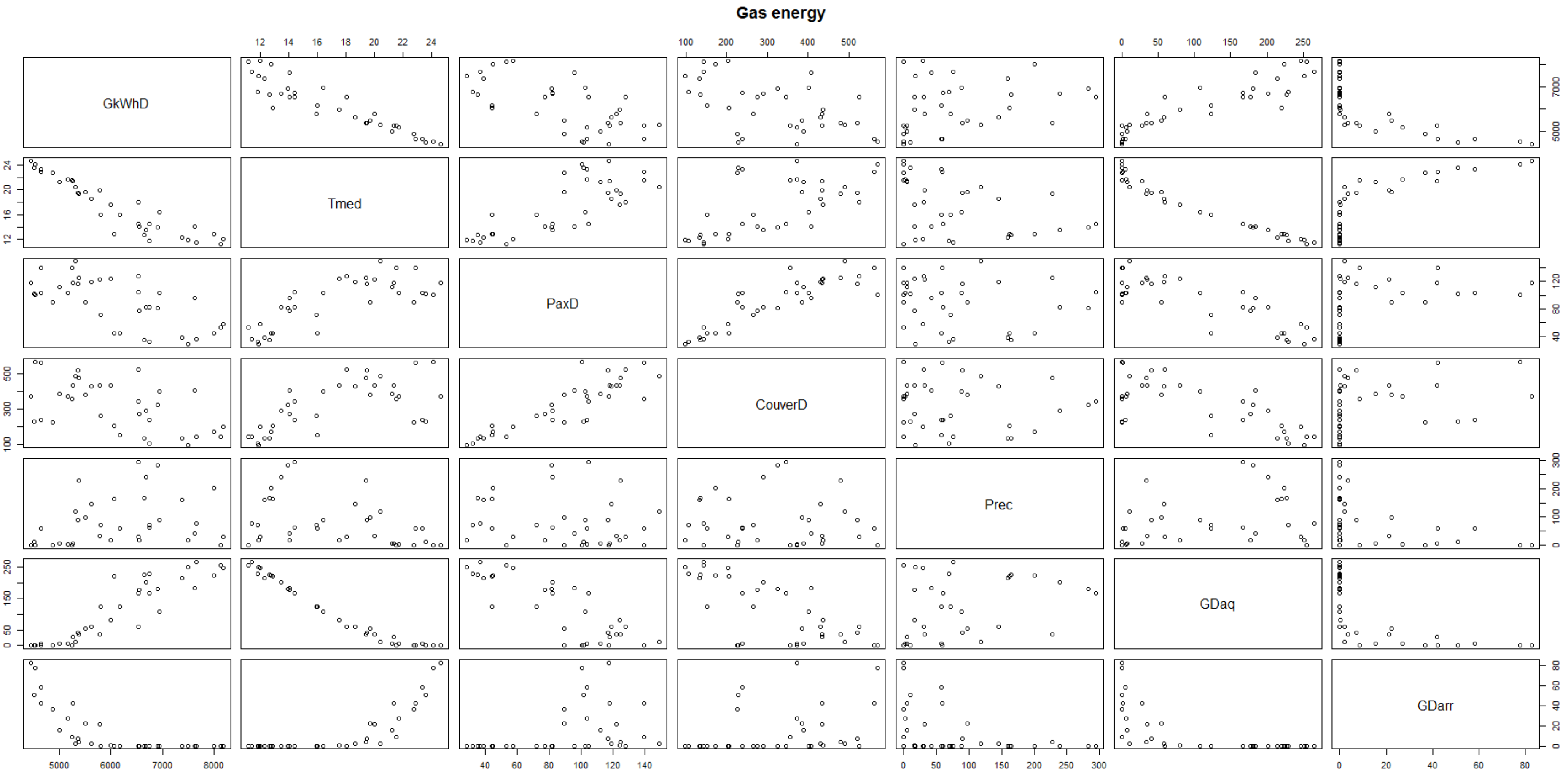

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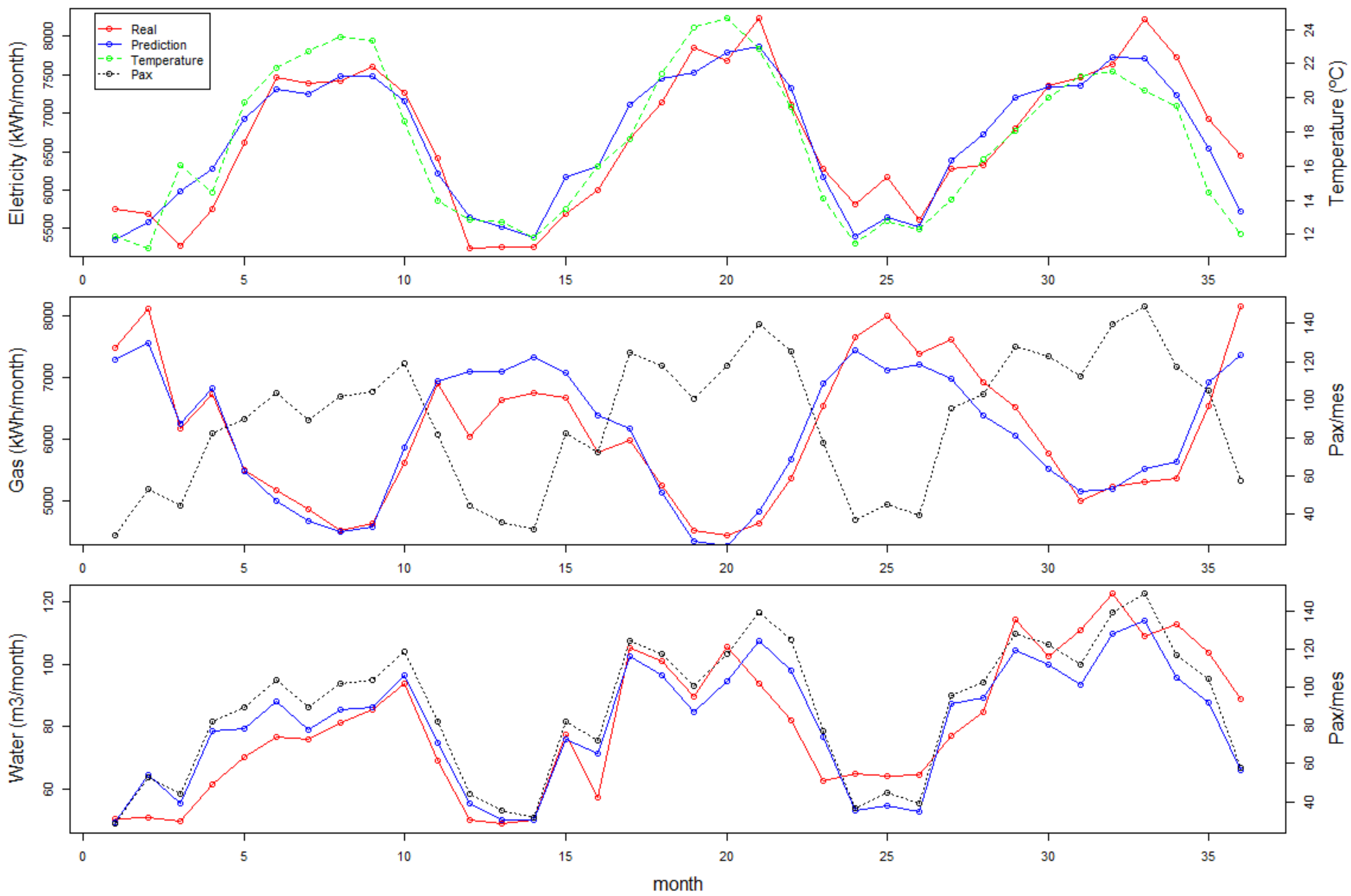
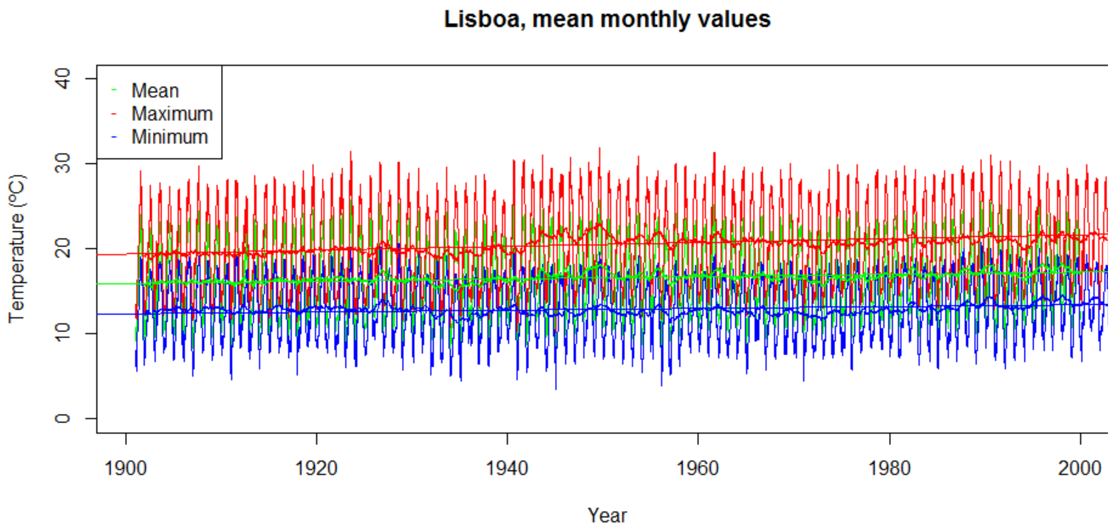
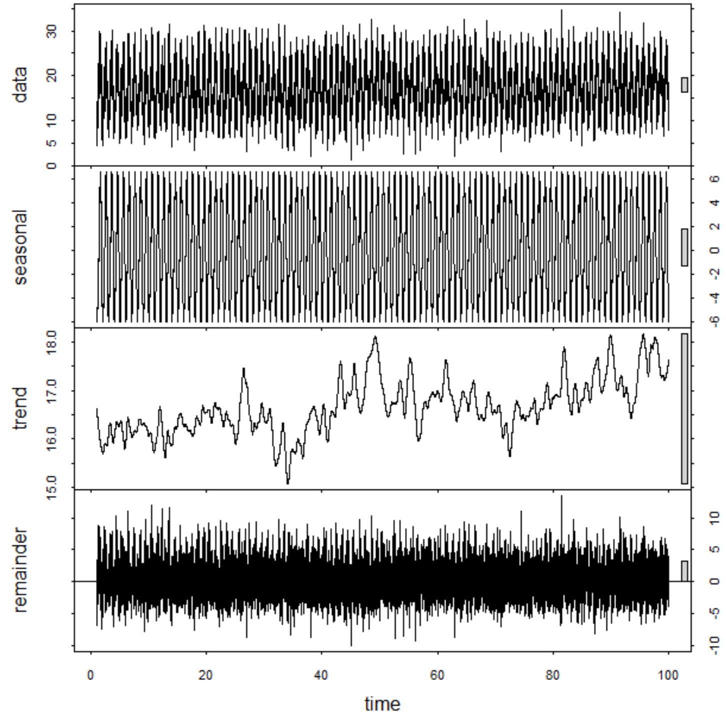


3 - METEOROLOGICAL DATA





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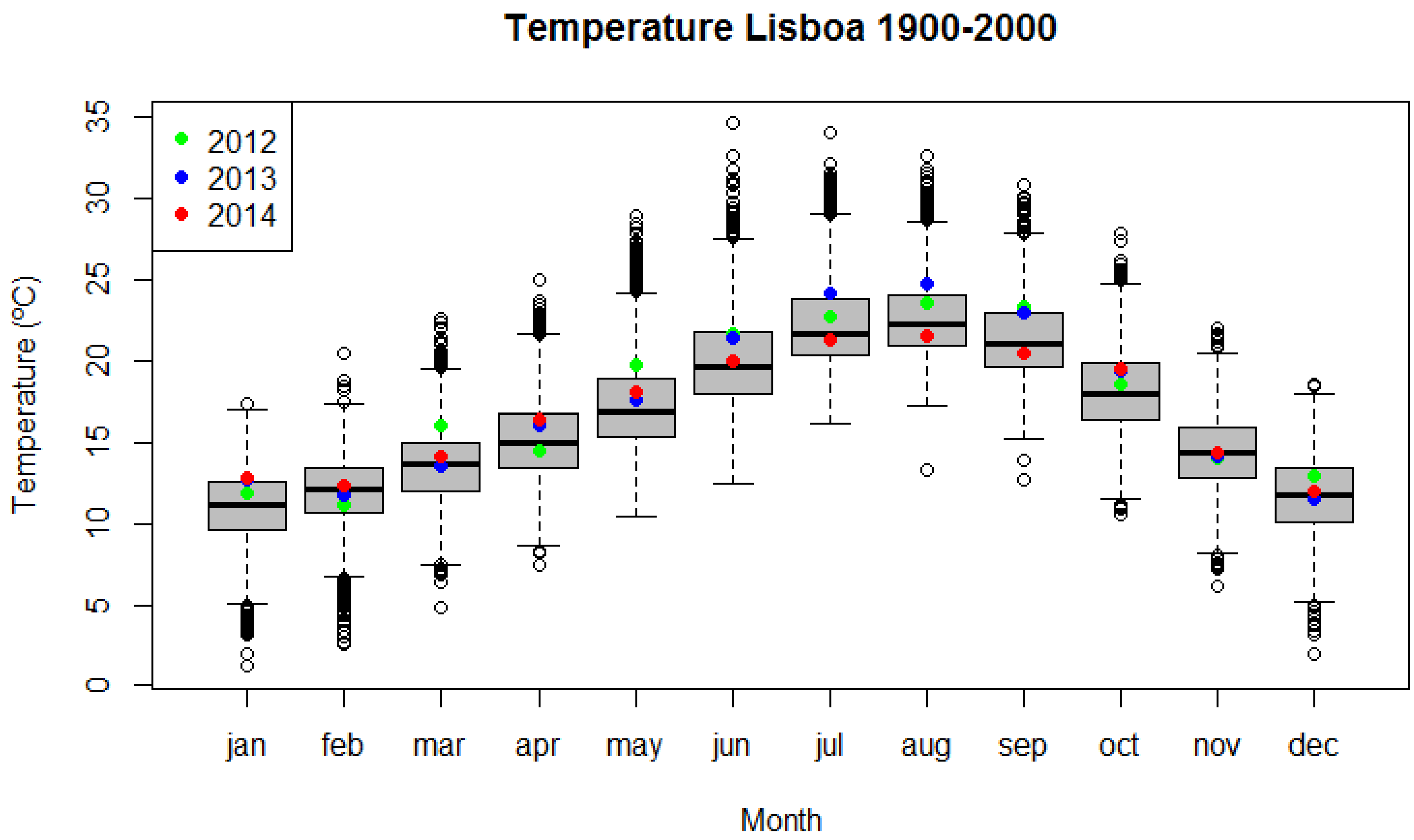
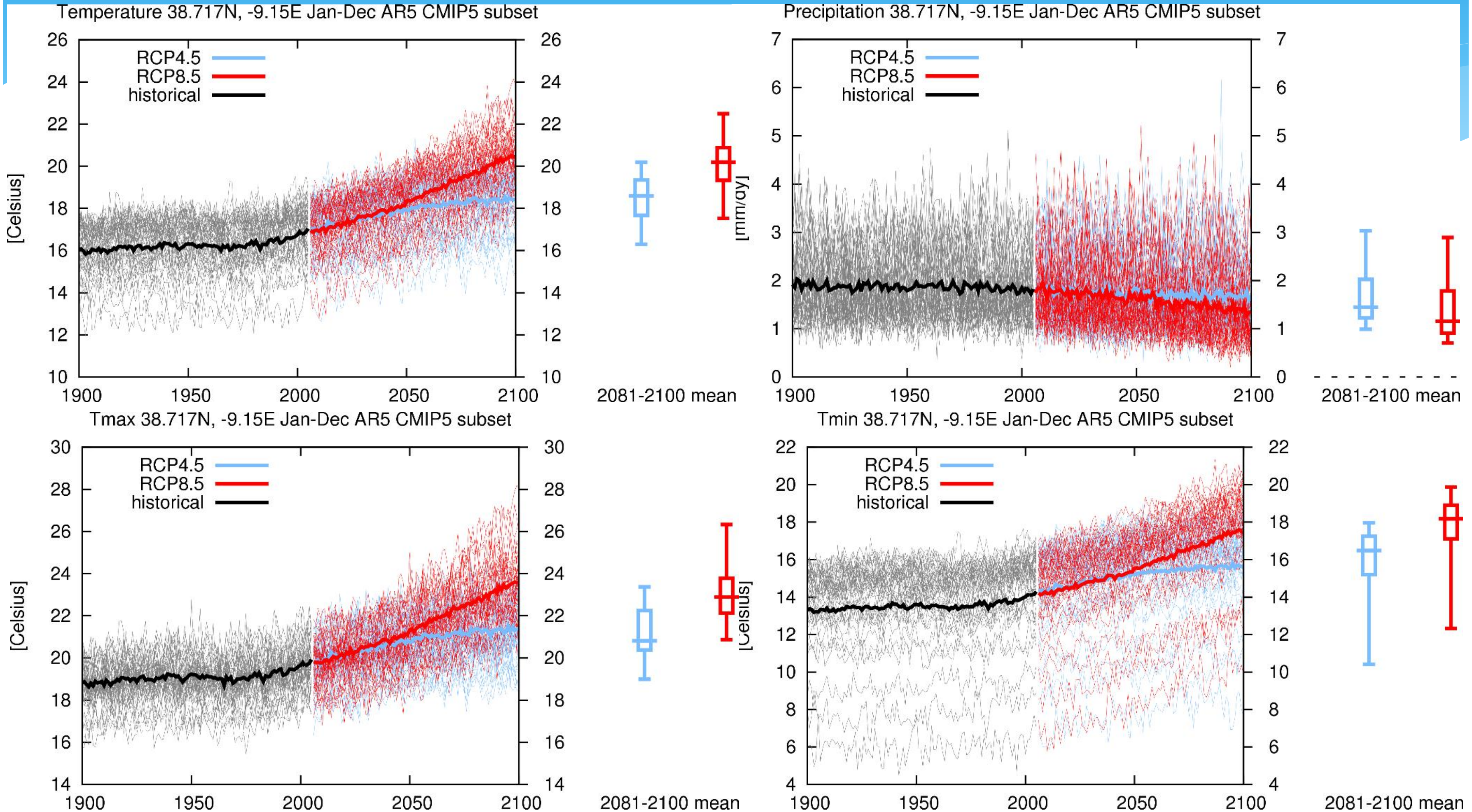


3 – Climate Change: Lisboa



4 – Case studies

Hotel n.º	Place	Nº beds:	N.º rooms	Average ocupancy annual	E eletricity (kWh/PAX)	E gas (kWh/PAX)	Water (l/pax)	Scenario RCP 8.5						Scenario RCP 4.5					
								E CC (2030 a 2050)	E CC (2080 a 2100)	G CC (2030 a 2050)	G CC (2080 a 2100)	W CC (2030 a 2050)	W CC (2080 a 2100)	E CC (2030 a 2050)	E CC (2080 a 2100)	G CC (2030 a 2050)	G CC (2080 a 2100)	W CC (2030 a 2050)	W CC (2080 a 2100)
1	Lisboa	380	180	<50%	49	46	609	0%	10%	-1%	-26%	1%	0%	2%	5%	-5%	-13%	0%	0%
2	Lisboa	252	126	<50%	29	13	511	0%	6%	0%	-29%	3%	44%	1%	3%	-5%	-15%	9%	21%
3	Lisboa	249	198	<50%	15	10	348	0%	16%	-1%	-32%	2%	34%	3%	8%	-6%	-16%	7%	16%
4	Lisboa	48	26	<50%	27	25	396	0%	10%	-1%	-26%	2%	1%	2%	5%	-5%	-13%	1%	0%
5	Lisboa	274	137	<50%	30	17	283	1%	16%	0%	-19%	2%	0%	3%	7%	-3%	-9%	1%	0%
6	Lisboa	56	28	<50%	36	65	1,079	0%	17%	-2%	-65%	1%	0%	3%	8%	-12%	-33%	1%	0%
7	Lisboa	140	70	50% a 70%	12	7	133	0%	17%	0%	0%	0%	0%	3%	8%	0%	0%	0%	0%
8	Lisboa	528	301	50% a 70%	22	1	421	0%	12%	0%	-3%	0%	0%	2%	6%	-1%	-2%	0%	0%
9	Lisboa	518	259	50% a 70%	8	19	162	1%	24%	-1%	-29%	0%	0%	4%	12%	-5%	-14%	0%	0%
10	Algarve	514	257	<50%	13	13	424	4%	29%	-15%	-97%	14%	86%	8%	16%	-30%	-57%	24%	47%
11	Algarve	624	312	<50%	27	21	715	6%	40%	8%	54%	15%	69%	12%	22%	16%	30%	22%	40%
12	Algarve	462	231	<50%	30	22	1,188	2%	10%	-22%	-150%	3%	12%	3%	5%	-47%	-92%	4%	7%
13	Algarve	128	55	<50%	17	19	618	2%	15%	-2%	-14%	6%	25%	4%	8%	-4%	-8%	8%	15%
14	Algarve	378	231	<50%	49	20	878	3%	22%	-3%	-23%	20%	119%	6%	12%	-7%	-13%	33%	64%
15	Algarve	508	182	<50%	23	20	497	9%	57%	-10%	-70%	12%	61%	16%	31%	-21%	-41%	18%	34%
16	Algarve	382	114	<50%	15	5	609	3%	23%	-11%	-74%	10%	56%	7%	13%	-23%	-43%	16%	31%

5 - Conclusions

* In 16 hotels, the relevant independent variable are temperature, occupancy and precipitation.
* With scenarios RPC 4.5 and RCP 8.5 (2030-2100):
  * an increase in electricity demand of 10% to 28% was estimated, mainly for air condition and refrigeration systems (28% Algarve, 14% Lisbon)).
  * an increase in water demand, probably for gardens and pools (50% Algarve, 9% Lisboa).
  * a decrease in energy demand for heating is expected.
* Algarve hotels are more vulnerable than Lisboa ones.
* Previous studied for Algarve Hotels, done with simulation, over predicted the energy consumptions (250 to 465 kWh/PAX vs 25 to 70 kWh/PAX) and the impact of CC in air conditioning.
* These results show the importance of adaptation plans in the hospitality sector to decrease cooling load demands, water use and also dependency from fossil fuels.
* The study of climate variability at smaller time scale (one day and even an hour) is being developed in the framework of AdaPT project.

Acknowledgments

Partners: