Risk assessment in an estuarine environment: a case-study in the Sado Estuary

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Photo of the Sado estuary, January 2011

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Background

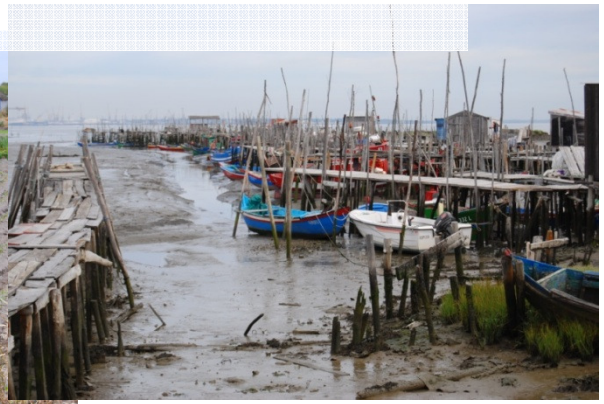
Previous environmental studies on Sado river estuary indicated high concentrations of heavy metals (Cu, Zn, Ni, As, Cr, e Pb) in sediments possibly linked to industrial contamination along with non-point anthropogenic sources;

This contamination was already detected on some species living in the estuary which can reflect and amplify local contamination, posing potentially serious health problems to humans;

Chronic heavy metal exposure is associated with renal and neurological diseases (especially in children during brain development);

Most heavy metals are also classified as carcinogenic and teratogenic.

- Local population has intense fishing activity.
- Along with agriculture products, fishery products of the estuary are daily available for local residents.



Although considerable investigation has been done assessing environmental contamination and its effects on ecological systems in this geographical area, studies of human exposure routes and its potential health effects due to heavy metals were never conducted.

An integrated, multidisciplinary research project was implemented aiming to evaluate environmental risks including ecologic and to human health, of the Sado estuary contamination.

HERA project
Environmental Risk Assessment of a contaminated estuarine environment: a case study

funded by Fundação para a Ciência e Tecnologia (FCT- PTDC/SAU-ESA/100107/2008)

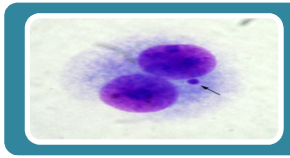
HERA project

Environmental Risk Assessment of a contaminated estuarine environment: a case study

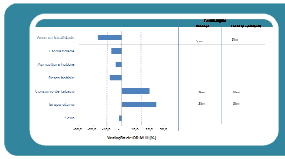
WP 1 - Epidemiological characterization of the target population of the village of Carrasqueira

WP 2 - Characterization of the contamination of local agricultural food

WP 3 -Sample collection and laboratorial quantification of sediments contamination and estuarine species bioaccumulation and health biomarkers



WP 4 -Characterization of the genotoxic and endocrine disrupting activities of sediments from areas of fishing activities



WP 5 - Data processing and data analysis for the association between food intake, human and endocrine disrupting genotoxicy and health effects

Objective

HERA project

Environmental Risk Assessment of a contaminated estuarine environment: a case study

WP 1 - Epidemiological characterization of the target population of the village of Carrasqueira

Characterizing exposure pathways and potential effects to human health

- To characterize exposure routes, health status, health determinants, and use of health care of all individuals residing in the target population, and

- To compare the same variables with those from a population sample of residents near another estuarine area located more than 200 km from the Sado river estuary (considered a prestine estuary).

Material and Methods

Study Design

Cross-sectional comparative study of residents in Carrasqueira (exposed population) and residents in a second different population, Vila Nova de Mil Fontes (VNMF), selected as the non-exposed population

A small riverside village in the south channel of the **Sado Estuary**

VNMF sits near another river estuary (Mira estuary) with similar fishing and agricultural activities but with no known industrial or other contamination exposures.

Planning Study consisted on the following steps:

Questionnaire design:

a. The first draft of the questionnaire resulted from previous knowledge of the population's habits about exposure characteristics, initial interviews with local residents and the inputs of the entire work team .
b. This draft was later on submitted to a pre-test that was held in the Health Center of VNMF

Ethical procedures: Study protocol and questionnaire submitted and approved by the ethics commission of the Portuguese National Public Health Institute and by the National Data Protection Commission.

To increase the level of participation, leaflet and posters were created and distributed in both populations before the field-work.

Leaflet

Poster

Field work

Sampling: Participants, from all ages and sex, were selected by simple randomization, using the medical registrations lists of local Health Centers.

Contact with selected participants:

- One week before the scheduled day for data collection, a letter was sent to each selected participant, explaining the purpose of the study and asking for participation of the contacted person.

Data collection: Data collected at home by trained interviewers by face to face interviews of selected individuals using Computed Assisted Personal Interview (CAPI), during June and July 2011.

Participants were included only after a written informed consent.

Field work

Final questionnaire included questions on:

1) Health effects: morbidity, use of health services, reproductive history;

2) Potential routes of exposure: socio-demographic, occupational (fishing and farming related occupations), leisure activities and hobbies (including recreational fishing), lifestyles (tobacco);

3) Potential routes of human contamination from the estuary (including use of water, subsistence fishing and farming).

Analysis

Data were checked for completion and consistency of pre-coded information.

Statistical analysis was performed using :

-descriptive analysis

-Chi-squared test

-Non-conditional logistic regression

Significance level was set at 5%.

Results

A total of 202 participants were included in the study

- 102 in Carrasqueira (response rate =72.9%)
- 100 in VNMF (response rate =45.7%)

Socio-Demographic Characteristics	Location			
	Carrasqueira (exposed)		VNMF (unexposed)	
	n	%	n	%
Age group (years)	102		100	
≤17		14.7		14.0
18- 44		29.4		26.0
45-64		40.2		33.0
65- 74		9.8		12.0
≥75		5.9		15.0

Comparison between exposed and unexposed: statistical significant differences in bold ($p<0.05$)
n, number of valid answers

Socio-Demographic Characteristics	Location			
	Carrasqueira (exposed)		VNMF (unexposed)	
	n	%	n	%
Education level	99		94	
No formal education		**14.1**		**11.7**
Primary and lower secondary education		**69.7**		**42.6**
Upper secondary education		**10.1**		**21.3**
Post - secondary or Higher education		**6.1**		**24.5**
Labour status	98		94	
Self employed		**38.8**		**11.7**
Employee		**23.5**		**34.0**
Fulfilling domestic tasks		**5.1**		**5.3**
Retired		**14.3**		**25.5**
Unemployed		**4.1**		**11.7**
Student		**14.3**		**11.7**

Comparison between exposed and unexposed: statistical significant differences in bold ($p<0.05$)
n, number of valid answers

Exposure Factors: Potential routes of exposure

Profession	Location			
	Carrasqueira (exposed)		VNMF (unexposed)	
	n	%	n	%
	80		84	
Managers, Professionals and Armed forces occupations		**8.8**		**10.4**
Technicians and associate professionals		**12.5**		**32.9**
Skilled agricultural, forestry and fishery workers; craft and related trades workers; plant and machine operators, and assemblers		**67.5**		**44.5**
Elementary occupations		**11.3**		**12.2**

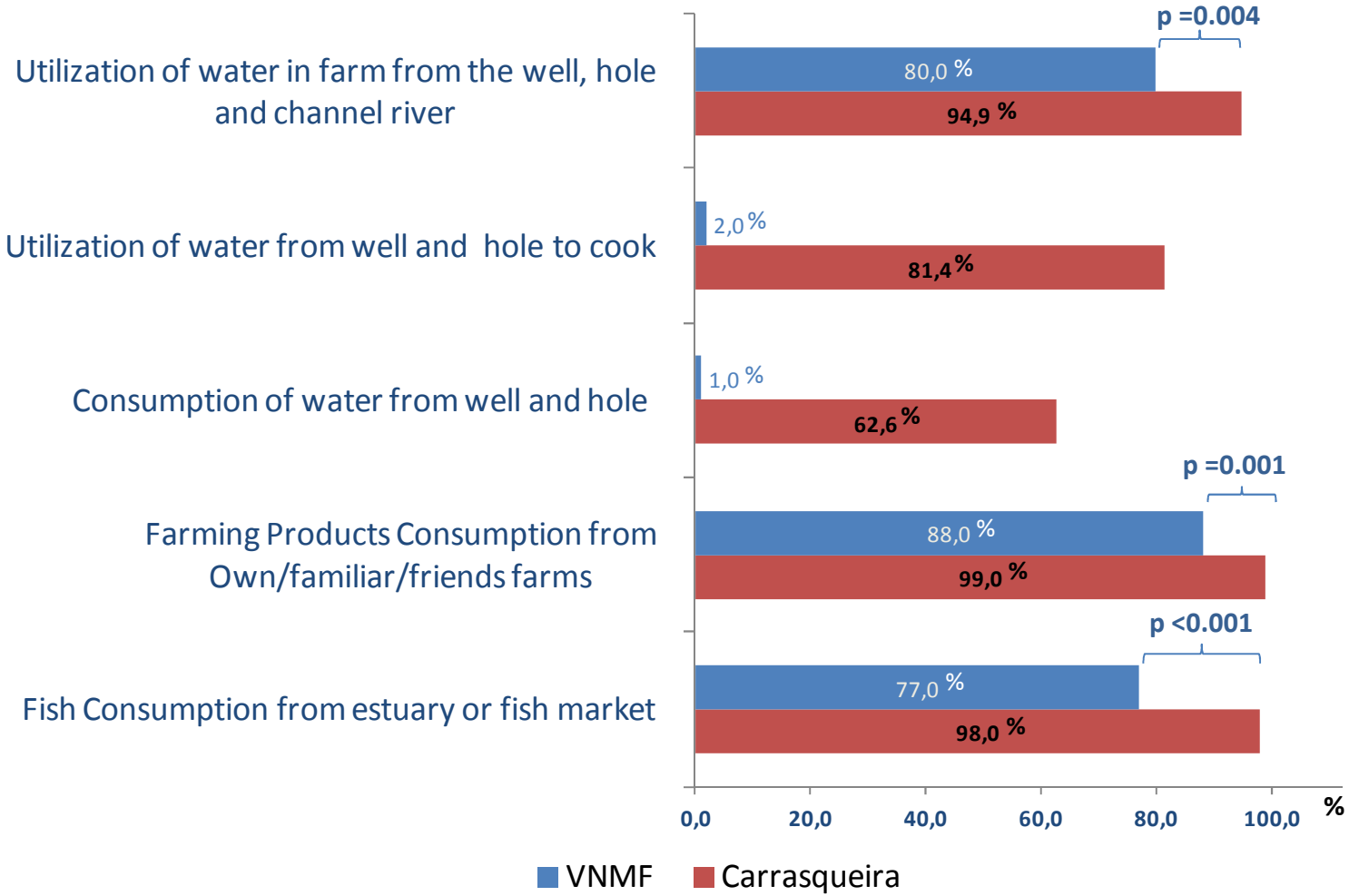
Comparison between exposed and unexposed: statistical significant differences in bold ($p<0.05$)
n, number of valid answers

Exposure Factors: leisure activities

Past or present Leisure Activities	Location			
	Carrasqueira (exposed)		VNMF (unexposed)	
	n	%	n	%
Fishing	99	**41.4**	94	**18.1**
Agriculture	99	**59.6**	94	**19.1**
Painting/ Joinery/Carpentry	102	**6.9**	100	**5.0**
Domestic activities (include gardening)	102	**26.5**	100	**14.0**
Others activities	102	**18.6**	100	**25.0**

Comparison between exposed and unexposed: statistical significant differences in bold ($p<0.05$)
n, number of valid answers

Exposure Factors: Potential routes of human contamination from the estuary



Health effects: morbidity

- A higher proportion of respondents in Carrasqueira declared to have a chronic disease confirmed by a medical doctor.
- Restricting the analysis to chronic heavy metal related morbidity (renal, kidney, neurologic and skin diseases) a higher prevalence of diseases was observed in the Carrasqueira population

Chronic heavy metal related morbidity	Location			
	Carrasqueira (exposed)		VNMF (unexposed)	
	n	%	n	%
At least one disease	102	**32.4**	100	**20.0**
1 disease	102	16.7	100	14.0
2 diseases	102	11.8	100	6.0
3 ou more diseases	102	3.9	100	0.0

Comparison between exposed and unexposed: statistical significant differences in bold ($p<0.05$)
n, number of valid answers

Health effects: reproductive history

A higher proportion of pregnancies with abnormal outcomes was found in the exposed village of Carrasqueira

At least one pregnancy with…	Location			
	Carrasqueira (exposed)		VNMF (unexposed)	
	n	%	n	%
Miscarriages (<20 Weeks) or Fetal Deaths	74	17.6	69	24.6
Abnormal outcomes	74	10.8	68	7.4

n, number of valid answers

Health effects

A higher odd of having chronic heavy metal related morbidity and pregnancies with abnormal outcomes were observed in Carrasqueira;

After adjustment , the odd risk of having at least one chronic heavy metal related disease was 2.1 (statistically significant).

At least one…	Comparison Carrasqueira (exposed)/ VNMF (unexposed)			
	OR	CI95%	OR adjusted*	CI95%
Chronic heavy metal related disease	**1.91**	**(1.00;3.64)**	**2.10**	**(1.02;4.30)**
Pregnancy with Miscarriages (<20 Weeks) or Fetal Deaths	0.65	(0.29;1.47)	---	---
Pregnancy with Abnormal outcomes	1.53	(0.47;4.92)	---	---

* Adjusted for age and years living in the local

Health effects: use of health services and health determinants

No significant differences were found in the rest of the health indicators in study

- *Self reported health status*
- *BMI*
- *Medical appointments and Hospitalizations*
- *Tobacco consumption*

Discussion and conclusions

Data collection and field work had no major drawbacks with a good response rate in the exposed population but lower in the comparison population.

Exposure pathways

The population of Carrasqueira had higher frequency of :

1. Professions like fishers and agricultures that are more likely to have higher risks of exposure to estuary river contaminants (directly or indirectly);
2. Leisure activities with higher probability of exposure
3. Consumption of fish from the local estuary or fish market, farming products, as well as water use for drinking, cooking and farming coming from well, holes or the channel river

Health effects

Carrasqueira location showed unfavorable morbidity and reproductive history indicators

These results should be analyzed carefully:

✓Small sample size, not dimensioned to the study design;

✓The cross sectional nature of the study does not allow conclusions on causality (but it should be noticed that the main objective of the study was the characterization of potential exposure);

These results should be analyzed carefully:

- ✓ They could be biased:
  - Differences on the non participants in both locations, particularly important in VNMF where the response rate was lower;
  - Information on diseases was self-reported, consultation of clinical process was denied due to the confidentiality of individuals health data;
  - Other exposure (such as food intake) not considered in the analysis at this time

Future Developments

- Expand data analysis including existing data on food intake.

- Repeat the study after 4-5 years , increasing the sample size and respective power

- Further studies should use bioindicators
  - Of exposure (such as heavy metals on blood)
  - Outcome (clinical data)

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Thank you

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