

**JAPAN INTERNATIONAL COOPERATION AGENCY [ JICA ]**

**SECRETARIAT OF COORDINATION AND PLANNING  
THE STATE OF RIO GRANDE DO SUL  
THE FEDERATIVE REPUBLIC OF BRAZIL**

**THE STUDY  
ON  
THE ENVIRONMENTAL MANAGEMENT  
OF  
THE HYDROGRAPHIC BASIN OF PATOS AND MIRIM LAKES  
IN  
THE FEDERATIVE REPUBLIC OF BRAZIL**

**FINAL REPORT : VOLUME 1**

**SUMMARY**

**OCTOBER 2000**

**KOKUSAI KOGYO CO., LTD.  
IN ASSOCIATION WITH  
PACIFIC CONSULTANTS INTERNATIONAL**

## **Exchange Rate of Currency**

**January, 2000**

**US\$1.00 = R\$1.75**

**R\$ =Brazilian Real**

## **Composition of the Final Report**

**The final reports are composed of the following 6 volumes.**

- 1. Vol.1 Summary**
- 2. Vol.2 Main Report**
- 3. Vol.3 Supporting Report**
- 4. Vol.4 Data Book**
- 5. Summary (Japanese)**
- 6. Summary (Portuguese)**

## PREFACE

In response to a request from the Government of the Federative Republic of Brazil, the Government of Japan decided to conduct a Development study on the Environmental Management of the Hydrographic Basin of Patos and Mirim Lakes in the Federative Republic of Brazil and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Dr. Akira Sugiyama of Kokusai Kogyo Co., Ltd. and consists of Kokusai Kogyo Co., Ltd and Pacific Consultants International to Brazil, four times between November 1998 and August 2000.

In addition, JICA set up an advisory committee headed by Jiro Eiho of Environmental Bureau, Hyogo Prefectural Government between November 1998 and October 2000, which examined the study from specialist and technical points of view.

The team held discussion with the officials concerned of the State Government of Rio Grande do Sul and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the State Government of Rio Grande do Sul for their close cooperation extended to the Team.

October, 2000



Kunihiko Saito

President

Japan International Cooperation Agency

October 2000

Mr. Kunihiro Saito  
President  
Japan International Cooperation Agency

## LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit the final report of "The Study on the Environmental Management of the Hydrographic Basin of Patos and Mirim Lakes in the Federative Republic of Brazil".

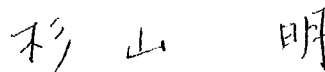
This report has been prepared based on the field survey in Brazil and the further studies in Japan conducted from November 1998 to October 2000.

This report proposes a master plan for environmental management, regarding 2010 and 2020, to rehabilitate and preserve the water quality of Patos Lake and the wetland ecosystem around Patos and Mirim Lakes to a sustainable level.

We sincerely hope that the implementation of this master plan would greatly contribute to the improvement of the environmental conditions around Patos and Mirim Lakes.

The Study Team wishes to express his sincere thanks to the personnel of your Agency and the Sao Paulo office, the Japanese Consulate General in Porto Alegre and the persons concerned in the State Government of Rio Grande do Sul.

Very truly yours,



Akira Sugiyama

Team Leader

The Study on the Environmental Management  
of the Hydrographic Basin of Patos and Mirim  
Lakes in the Federative Republic of Brazil

## **OUTLINE OF THE STUDY RESULTS**

### **1 . Objectives of the Study**

- (1) To formulate a water quality control plan that underscores strengthened water quality monitoring activities and wetland conservation for the Patos and Mirim lake areas.
- (2) To transfer technology to the Brazilian counterparts during the study.

### **2 . Study Area**

The study covers Patos and Mirim lakes basin which is approximately 150,000km<sup>2</sup>. Because of the IDB financed Pro Guaíba Program in the Guaíba River basin, which is in the northern half of the Patos lake basin, only pollution load analysis based on available data was carried out therein. The study, therefore, mainly covered the Mar de Dentro area (approximately 66,000km<sup>2</sup> with a population of 1 million) , which makes up the southern half of Patos Lake basin.

### **3 . Present Environmental Conditions in the Patos and Mirim Lakes Area**

The Patos and Mirim lakes in the southern region of the state of Rio Grande do Sul are suffering from water quality contamination and sedimentation due to the inflow of domestic and industrial wastewater from the basin, felling activities, and the excessive use of agro-chemicals for cultivation. The expansion of farmlands and encroaching domestic animals have also resulted in changes in vegetation and loss in bio-diversity in nearby wetlands.

As for water quality, human excreta (bacteria) has seriously contaminated the downstream section of rivers flowing through urban areas, e.g. Pelotas, São Lourenço do Sul, etc., and along the west coast of Patos Lake. This does not only deteriorate the urban living environment but also prevent lake-shore utilization for recreational purpose. Nutrient salt (nitrogen and phosphorus) level is also high in Patos Lake except the central water section through a year. This eutrophic level is foreseen to obstruct the use of the water for various purpose. The slope areas in the Sutil and Duro river basins and the Canguçu area are considered to be the most highly prone to soil erosion.

## **4 . Problems**

In view of the previously mentioned present environmental conditions in the Patos and Mirim Lakes area as and how environmental administration is implemented at present in the RS state, the following seven (7) items are the issues relevant to water quality conservation to be addressed and resolved.

- (1) Solving contamination by human excreta
- (2) Prevention of eutrophication
- (3) Solving contamination by organic substances
- (4) Actual understanding of contamination by agro-chemicals and heavy metals
- (5) Strengthening monitoring of industrial pollution sources
- (6) Joint use of information on water quality
- (7) Promotion of environmental education

On the other hand, the following are the five issues regarding wetland ecosystem conservation that need to be addressed and resolved.

- (1) Promote understanding of the value of wetlands
- (2) Organize a wetland committee
- (3) Preservation of significant wetlands and facility construction
- (4) Promote wise use of the wetlands
- (5) Collection and making public of information on wetland ecosystem

## **5 . Outline of the Master Plan**

### **5-1 Target Area**

For the restoration and conservation of the environment in the Patos and Mirim lake areas, a plan solely targeting these objectives should be made. As above mentioned, however, this study will focus on the Mar de Dentro area (approximately 66,000km<sup>2</sup>) and as such the master plan will restrictively cover the same area, excluding the Guaíba River basin.

## 5-2 Components

To solve the problems aforementioned, a Master Plan with the following eight components was presented.

(1) Water Quality Control Plan, (2) Sewage Treatment Plan, (3) Solid Waste Management Plan, (4) River and Basin Management Plan, (5) Wetland Ecosystem Conservation Plan, (6) Water Quality and Hydrological Monitoring Plan, (7) Organizational Strengthening and Joint Information Use Plan, (8) Environmental Education and Capacity Building Plan

## 5-3 Target

The medium and long term target level of the Master Plan were established with due consideration of the present deteriorating state of the aquatic environment and the wetland ecosystem, the needs of the residents, scale of the countermeasures to be adopted, and the time it would take for the countermeasures to take effect. These targets are shown in the following table.

<b>Target Level Target Year</b>	<b>Water Quality</b>	<b>Wetland Ecosystem</b>
Targets for the Medium Term ( 2010 )	<p>Solving contamination by human excreta</p> <p>To attain the no. of fecal coliform groups (annual average) designated by water section</p> <p>A Class: less than 1,000MPN/100ml B Class: less than 1,000MPN/100ml C Class: less than 1,000MPN/100ml D Class: less than 4,000MPN/100ml</p> <p>For water areas used for recreation, however, the following should be attained during the peak season</p> <p>Less than 250MPN/100ml (primary) Less than 500MPN/100ml (secondary)</p>	<ol style="list-style-type: none"> <li>Promote understanding of the value of wetlands <ul style="list-style-type: none"> <li>• Training of the staff of government agencies, schools, environmental NGOs.</li> <li>• Attain the target number of users of the visitor center</li> </ul> </li> <li>Conservation of significant wetlands (Del Rey wetland, Camaqua riverine forest, Pequena Lake, S. Goncalo canal) <ul style="list-style-type: none"> <li>• Maintain bio-diversity (number of species)</li> <li>• Maintain wetland area and water level</li> </ul> </li> </ol>
Targets for the Long Term ( 2020 )	<p>Solving problems concerning eutrophication and soil runoff</p> <p>To attain the TP level (annual average) established for every water section.</p> <p>A Class: less than 0.03mg/l B Class: less than 0.05mg/l C Class: less than 0.05mg/l</p> <p>For the majority of the northern water section, B class will be applied, while A class will be applied to the central and eastern sections, and C class will be designated for the most part of the southern water sections.</p>	<ol style="list-style-type: none"> <li>Promote understanding of the value of wetlands Have at least 1 member of every household in the study area visit the wetlands.</li> <li>Preservation and recuperation of other wetlands Restoration and preservation of essential vegetation.</li> </ol>

## **5-4 Program and Projects**

To attain the targets shown in the above table, it is necessary to implement the following twenty three (23) projects arranged in the seven programs. The implementation in the Mar de Dentro Area of projects marked with an asterisk should be given priority. The rest will be implemented in the entire RS state.

### **1. Point source load reduction program**

#### **(1) Construction of domestic wastewater collection and treatment system \***

Expansion of municipal sewerage network and construction of a sewage treatment plant in Pelotas, Rio Grande, Sao Lourenco do Sul, Tapes and Camaqua

#### **(2) Strengthening of industrial wastewater monitoring activities \***

Creating an inventory on industrial wastewater generation sources

#### **(3) Promotion of cleaner production**

Introduction and guidance of desirable production processes by industrial type

### **2. Non-point source load reduction program**

#### **(4) Improvement of domestic solid waste collection and disposal system \***

Establishing a separate collection system, providing collection equipment and constructing a sanitary landfill site in Pelotas, Rio Grande, Sao Lourenco do Sul, Tapes and Camaqua

#### **(5) Promotion project of an environmental conservation oriented agriculture \***

Introduction of an environmental conservation oriented agricultural system, including soil runoff prevention and the reduction of agricultural chemical use into the Canguçu are

#### **(6) Project for soil erosion and soil runoff prevention \***

Implementation of soil erosion and soil runoff prevention measures including terracing, afforestation/reforestation, etc., in the catchment areas



of the Stil and Duro rivers.

### 3. Wetland ecosystem restoration and conservation program

- (7) Awareness and expansion project on the functions of a wetland ecosystem\*

Planning and implementation of events and hands –on-training in concert with the wetland committee and NGO.

- (8) Conservation of important wetlands \*

Establishment of development regulation, water level maintenance, and construction of visitor center and access roads for the Del Rey wetland, Camaqua riverine forest, Sao Goncalo canal and Pequena lake.

### 4. Establishment of a hydrological and water quality monitoring system program

- (9) Transfer of monitoring techniques \*

Transfer of techniques to the municipality and NGO through the formulation of manuals on observation and sampling, as well as hands-on-training.

- (10) Monitoring facility expansion project \*

Providing the equipment for the surveys and observation works and construction of laboratories

### 5. Joint use of environmental information program

- (11) Construction of an environmental information database \*

Data base construction and mapping of environmental information held in every sector , and publishing of the results in the web site.

### 6. Environmental education and personnel capacity building program

- (12) Dissemination of environmental education activities \*

(13) Expansion of environmental education facilities \*

(14) Training of local administrative personnel

#### 7. Surveys and monitoring program

(15) Surveys on generation load per unit production

(16) Surveys on actual contamination by agricultural chemicals \*

(17) Water quality monitoring of Patos Lake \*

(18) Water quality survey in the southern water section of Patos Lake \*

(19) Survey for the formulation of the Mirim Lake water quality control plan

(20) Survey for the formulation of the Camaqua River basin conservation plan\*

(21) Survey for the formulation of the Piratini River basin conservation plan \*

(22) Survey for the formulation of the Guaíba River basin water quality management plan

(23) Survey for the formulation of leachate prevention measures at the existing disposal site in Rio Grande \*

### **5-5 Implementation Cost of the Priority Projects**

The selected priority projects were classified into seven categories, and the cost of each category was roughly estimated. The estimated total initial cost, annual operation & maintenance cost, and the total renewal cost are US\$ 66,031,970, US\$ 6,620,250, and US\$ 31,141,000, respectively.

## **6 . Project Evaluation**

The benefits that can be gained from the attainment of the targets were estimated and compared with the implementation cost of the selected seven priority projects. Calculation for scenarios assumed under Case 1 showed an IRR of 13.10%, B/C of 1.31, and NPV of US\$31,735,700 ( assuming a discount rate of 10% ) . The benefits were calculated to exceed the project cost even if the latter increases by 10% and the former decreases by 10% as well. Further the results of the technical evaluation and the environmental impact assessment did not indicate any particular difficulties. Therefore,

the priority projects proposed in this Master Plan are really worth implementing.

## **7 . Recommendations**

- (1) The state of Rio Grande do Sul should, as soon as possible, formulate a development plan in harmony with the master plan proposed herein in accordance with the basic policies of the Mar de Dentro Program, which was implemented to develop the characteristics and potential of the area in order to increase the income of and create job opportunities for the residents.
- (2) Under the traditional land ownership system in the state of Rio Grande do Sul, many areas are careless with the use of the land and landowners are really not that concerned about developing an environmental conservation oriented agriculture and soil erosion and runoff prevention measures. But for the implementation of non-point source countermeasures landowners should be made to understand that these will improve land productivity in the long run, and their cooperation in the implementation of the measures should be acquired
- (3) Since actual production activities and wastewater and solid waste management conditions in the industrial point sources in the Mar de Dentro area not known, these will be determined, and monitoring will be carried out to determine the water quality in surrounding water areas.
- (4) In the master plan, the concept adopted for the sewage treatment plan for Pelotas and Rio Grande and the solid waste management plan for Pelotas is very basic. To come up with concrete schemes, the implementation of a feasibility study is required.
- (5) The runoff load from the Guaíba River basin makes up about 60% of the Patos Lake inflow load, and this is particularly evident in the northern half of the lake where eutrophication is reaching a critical level. In the future, it is necessary to incorporate into the PRO-GUAIBA Program sewage treatment and basin conservation measures that would affect nutrient salt reduction.
- (6) The state of Rio Grande do Sul should hasten the implementation of the policies proposed in the master plan based on the experiences gained from the preceding PRO-GUAIBA Program. In addition, the state should also expedite the strengthening of the planning and coordinating functions of SEPMD, the

executing secretariat for the Mar de Dentro Program.

- (7) The results of calculations using the runoff load simulation model, the hydraulic and water quality simulation model developed in this study, and the water quality monitoring results should be compared incessantly, to clearly identify the factors affecting changes in lake water quality and to establish more effective countermeasures.

## LIST OF ABBREVIATIONS

### Organizations

**ABC** ( Agencia Brasileira de Cooperacao ) : Brazilian Cooperation Agency

**ALM** ( Agencia da Lagoa Mirim ) : Agency of Lake Mirim

**APEDEMA/RS** ( Assembleia Permanente de Defesa do Meio Ambiente do RS)

: Assembly for Environmental Deficiency of RS State

**CEA** ( Centro de Estudos Ambientais ) : Center for Environmental Studies

**CEFET** ( Centro Federal de Educacao Tecnologica ) : Federal Center of Technical Education

**CEPSRM** ( Centro Estadual de Pesquisa em Sensoriamento Remoto e

Meteorologia ) : Remote Sensing and Meteorological Reserch Center attached to the State University of Rio Grande do Sul

**CIENTEC** ( Fundacao de Ciencia e Tecnologia ) : Foundation of Science and Technology

**CMA/RBPM**(Conselhos Municipais Ambientais da Regiao da Bacia Patos-Mirim)

: Municipal Council for Environment of the Region of Patos-Mirim Basin

**CONRHIRGS** ( Conselho Estadual de Recursos Hidricos ) : State Council for Water Resource Development

**CONSEMA** (Conselho Estadual de Meio Ambiente) : State Council for Environment

**COREDE** (Conselho de Regional de Desenvolvimento) : Council for Regional Development

**COREDE-SUL** (Conselho Regional da Regiao Sul ) : Promotion Committee for the Southern Region of RS State

**CORSAN** ( Companhia Rio Grandense de Saneamento ) : State Public Corporation for Water Supply and Sewage Treatment

**CPRM** ( Companhia de Pesquisas de Recursos Minerais ) : Research Corporation for Mineral Resources

**C/RBPM** (Comites de Regiao da Bacia Patos-Mirim) : Committee for the Region of Patos-Mirim Basin

**DEPRC** ( Superintendencia de Portos e Hidrovias ) : Superintendence of Port and Waterway

**DHN** ( Diretoria de Hidrografia e Navegacao, Marinha do Brasil ) : Hydrographic and Navigation Division of the Navy of Brazil

**DMAE** ( Departamento Municipal de Agua e Esgoto ) : Municipal Department of

Water Supply and Sewage Treatment

**DNAEE** ( Departamento Nacional de Aguas e Energia Electrica ) : Federative  
Department of Water, Energy and Electricity

**DSG** ( Divisao de Servico Geografico do Exercicio ) : Geographic Division of  
Military of Brazil

**EMATER** ( Associacao Riograndense de Empreendimentos de Assistencia  
Tecnica e Extensao Rural ) : Enterprise for Technical Assistance

**EMBRAPA** ( Empresa Brasileira de Pesquisa Agro-pecuaria ) : Federal Research  
Institute for Agriculture and Farming

**FAMURS** ( Fedetacao das Associacoes de Municipios do Rio Grande do Sul ) :  
Association of Municipals of RS State

**FEE** ( Fundacao de Economia e Estatistica ) : Foundation of Economics and  
Statistics

**FEPAGRO** ( Fundacao Estadual de Pesquisa Agropecuaria ) : Research  
Foundation of Agriculture and Farming

**FEPAM** ( Fundacao Estadual de Protecao Ambiental Henrique Luiz Rossler/RS ) :  
State Foundation for Environmental Protection

**FURG** ( Fundacao Universidade do Rio Grande ) : Federal University of Rio Grande

**FZB** ( Fundacao Zoobotanica ) : State Foundation for Zoology and Botany

**GEEPA** ( Grupo Especial de Estudo e Protecao do Ambiente Aquatico ) : Group  
for the Study and Protection of the Aquatic Environment

**GTZ** : (Deutsche Gesellschaft fur Technische Zusammenarbeit) : Organization for  
Technical Cooperation of German

**IBAMA** ( Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais  
Renovaveis ) : Federal Institute of Environment and Natural Resources

**IDG-UFRGS** ( Instituto de Geociencias ) : Institute of Geoscience attached to the  
Federal University of Rio Grande do Sul

**INMET**(Instituto Nacional de Meteorologia) : Federal Institute of Meteorology  
attached to the Ministry of Agriculture

**IPH** ( Instituto de Pesquisa Hidraulicas da Universidade Federal do Rio Grande do  
Sul ) : Hydraulic Research Institute attached to the Federal University of Rio  
Grande

**IRGA** ( Instituto Riograndense do Arroz ) : Institute of Rice Crop in Rio Grande

**JICA** : Japan International Cooperation Agency

**KK** : Kokusai Kogyo Co. Ltd.

**MCT** ( Ministerio de Ciencia e Tecnologia ) : Ministry of Science and Technology

**METROPLAN** ( Fundacao de Planejamento Metropolitano e Regional ) :

Foundation of Planning for Metropolitan

**NEMA** (Nucleo de Educacao e Monitoramento Ambiental) : Center for  
Environmental Monitoring and Study

**NGO** : Non-Governmental Organization

**PCI** : Pacific Consultants International

**PMD** (Secretario Executivo do Pragma Mar de Dentro) : Mar de Dentro Program

**PMP** (Prefeitura Municipal de Pelotas) : Pelotas City

**PMRG** (Prefeitura Municipal de Rio Grande) : Rio Grande City

**RS** : The Sate of Rio Grande do Sul

**SAA** (Secretario da Agricultura e Abastecimento) : Secretariat of Agricultural  
Production of RS State

**SANEP** ( Servico Autonomo de Saneamento de Pelotas ) : Service Agency of  
Pelotas for Water Supply and Sewage Treatment

**SCP** ( Secretario da Coordenacao e do Planejamento ) : Secretariat of Coordination  
and Planning of RS State

**SE** (Secretario da Educacao) : Secretariat of Education of RS State

**SEMA** (Secretario do Meio Ambiente) : Secretariat of Environment of RS State

**SF** (Secretario da Fazenda) : Secretariat of Finance of RS State

**SOPSH** (Secretario das Obras Publicas, Saniamento e Habitacao) : Secretariat of Public  
Works, Sanitation and Residences

**SUPRG** (Superintendencia do Porto de Rio Grande) : Superintendent of Rio  
Grande Port

**UCPEL** ( Universidade Catolico de Pelotas ) : Catholic University of Pelotas

**UFPEL** ( Universidade Federal de Pelotas ) : Federal University of Pelotas

**UFRGS** ( Universidade Federal de Rio Gande do Sul ) : Federal University of Rio  
Grande do Sul

**ULBRA** ( Universidade Luterana do Brasil ) : Luther University of Brazil

**UNISINOS** ( Universidade do Vale do Rio dos Sinos ) : Sinos University

**WHO** : World Health Organization

### **Chemical Terms**

**AA** : Atomic Absorption Spectrometer  
**APHA** : American Public Health Association  
**As** : Arsenic  
**BOD** : Biochemical Oxygen Demand  
**Cd** : Cadmium  
**Chl-a** : Chlorophyl-a  
**Cl** : Chlorine  
**CN** : Cyanide  
**COD** : Chemical Oxygen Demand  
**COD(Cr)**:COD(Potassium Bichloride Method)  
**COD(Mn)**:COD(Potassium Perman-ganate Method)  
**Cr** : Chrome  
**Cu** : Copper  
**DO** : Dissolved Oxygen  
**Fe** : Iron  
**Hg** : Mercury  
**Ig-Loss** : Ignition Loss  
**IN** : Inorganic Nitrogen

**IP** : Inorganic Phosphate  
**NH<sub>4</sub>-N** : Ammonia Nitrogen  
**Ni** : Nickel  
**NO<sub>2</sub>-N** : Nitrite Nitrogen  
**NO<sub>3</sub>-N** : Nitrate Nitrogen  
**ON** : Organic Nitrogen  
**OP** : Organic Phosphorus  
**ORP** : Oxidation Reduction Potential  
**Pb** : Lead  
**pH** : Potential of Hydrogen  
**POC** : Particular Organic Carbon  
**PON** : Particular Organic Nitrogen  
**PO<sub>4</sub>-P** : Phosphoric Phosphate  
**SPM** : (correspond to **SS**)  
**SS** : Suspended Solid  
**TOC** : Total Organic Carbon  
**TN** : Total Nitrogen  
**TP** : Total Phosphorus  
**TS** : Total Solid  
**TV** : Total Volatile  
**Zn** : Zinc

### **Economic Terms**

**B/C** : Benefit Cost Ratio  
**EIRR** : Economic Internal Rate of Return  
**FIRR** : Financial Internal Rate of Return

**GDP** : Gross Domestic Products  
**IRR** : Internal Rate of Return  
**PPP** : Polluter Pays Principle  
**WSP** : Willingness to Pay

### **Unit of Measurement**

**km** : kilometer  
**m** : meter  
**cm** : centimeter

**mm** : millimeter  
**km<sup>2</sup>** : square kilometer  
**ha** : hectare



**m<sup>3</sup>** : cubic meter

**L** : liter

**kg** : kilogram

**g** : gram

**mg** : milligram

**µg** : microgram

**sec** : second

**MPN** : Most Probable Number

**NTU** : Nephelometric Turbidity  
Units

### **Reports**

**S/W** : Scope of Work

**IC/R** : Inception Report

**P/R** : Progress Report

**IT/R** : Interim Report

**DF/R** : Draft Final Report

**F/R** : Final Report

### **Others**

**ADCP** : Acoustic Doppler Current  
Profiler

**APA** : Areas for Environmental  
Protection

**C/P** : Counterpart Personnel

**EIA** : Environmental Impact  
Assessment

**EAA** : Everglades Agricultural Area

**GC-MS** : Gas Chromatography Mass  
Spectrometer

**GIS** : Geographic Information System

**IPTU** : Urban and Territorial  
Praedial Tax

**OM** : Operation and Maintenance

**RPPN** : Private Reserves of Natural  
Patrimony

## LIST OF COLLABORATORS

Many people from several sectors of RS State Government, universities, municipal government, NGOs, etc., collaborated with the implementation of this study by offering information or data and in assisting in field surveys or laboratory experiments. The names of these people are listed below.

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