TASKS FOR VEGETATION SCIENCE – 43

Mangroves and Halophytes
Restoration and Utilisation

edited by

Helmut Lieth, Maxímo García Sucre and Brigitte Herzog

Springer

MANGROVES AND HALOPHYTES:
RESTORATION AND UTILISATION

Tasks for Vegetation Sciences 43

SERIES EDITOR

H. Lieth, *University of Osnabrueck, Germany*

The titles published in the series are listed at the end of this volume

Mangroves and Halophytes: Restoration and Utilisation

Edited by

HELMUT LIETH

Institute of Environmental Systems Research
University of Osnabrueck
D-49069 Osnabrueck
Germany

MAXÍMO GARCÍA SUCRE

IVIC (Instituto Venezolano de Investigaciones Scientificas)
Aptdo.21827, Caracas 1020-A, Venezuela

and

BRIGITTE HERZOG

OSTRin i.R Justinus-Kerner-Gymnasium
74189 Weinsberg
Germany

Springer

A C.I.P. catalogue record for this book is available from the Library of Congress

ISBN 978-1-4020-6719-8 (HB)
ISBN 978-1-4020-6720-4 (e-book)

Published by Springer,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands

www.springer.com

Printed on acid-free paper

Foreword

Foreword by the Editor of the T:VS Series, Volume 43

Helmut Lieth
Prof. em. University of Osnabrueck
Prof. h.c. Uzbek Academy of Sciences,
IWP Tashkent

During 2005 the editors of this volume started to enlarge the work of the international society of halophytes utilisation (ISHU) from their previous concentration of the Old World to include also the New World. In this region the main interests on halophytes were reported from North America. We had already used a number of species from this region in the field experiments of the ISHU projects around the Mediterranean Sea, but little was known about the performance of these species in South America. Some of our members were interested in using species from this region in other areas of the world, but before doing so they wanted more information about the performance of these species in competition with native plants in the new environments.

From the South American regions one of the editors (Lieth) had long time experiences with salinity problems and had worked with scientists in Venezuela and Colombia. Other members of the ISHU group of scientists had interest in starting projects in the region as well. It was therefore convenient for the entire group to renew the contacts with the scientists from this region, although the working conditions as well as the political environment had drastically changed.

With the help of our old friends and the generous help of the DAAD section for South America, it was possible to develop in 2005 the cooperation with the ecological section of IVIC in Venezuela. The new political and public awareness situation in Venezuela made it possible for the new director of IVIC, Dr. M. Garcia-Sucre, to establish international cooperation on the coastal ecosystems protection, which was needed because of the heavy impact the oil and gas pipelines had inflicted upon several of the mangrove ecosystems as well of the inland semidry areas.

Several members of the European ISHU and several Venezuelan colleagues contributed to the seminars in IVIC/Caracas and several German Universities in Osnabrueck, Giessen, Bremen and Hanover. This volume compiles the papers presented at these meetings as well as contributions which were triggered by these seminars.

It was advantageous for the work on this volume that OSTRin Brigitte Herzog agreed to cooperate with the other members of the group on the seminars as well as in the publication of the volume. She had previous contact with several persons in Venezuela and with some of the persons contributing to the volume from Germany.

We thank all foundations and private individuals who contributed to the project and made it possible to link their work, mostly done in countries of the Old World, with projects of interest to the New World.

Opening of the Seminars

Expectations from the Workshop with Regard to the Utilisation of Mangroves and Halophytes in Venezuela, in the Coastal Regions as well as for Inland Agriculture on Saline Soils

by M. García Sucre

It is currently believed that the possibility of using the saline soils in agriculture in order to prevent famine in the developing countries remains remote. Even the conservation of mangroves has received little attention in the Caribbean region. If we start to work from now on these problems, we will have scientific and technical solutions for them in 10 years, presumably. How many people will live in the Caribbean countries in the next decade? At the rate of the mean growing population, we will have at least 40% more people to feed. Yet, the production of food is even today an unsolved problem in the majority of these countries. This is the case in Latin America, not to speak of Africa and some regions of Asia. Thus, the task of working in the utilisation for the production of food in soils that are now useless for that purpose seems to us of an overwhelming importance.

Venezuela is not an exception concerning the problem of food production. In this concern, one of the priorities of the Government of Venezuela is to promote what has been called *Seguridad Alimentaria* in our country. Along this line we decided to organise two workshops on ‘Rehabilitation of mangroves and sustainable utilisation of halophytes’, one in January 2006 at the Instituto Venezolano de Investigaciones Científicas (IVIC) in Venezuela, and the other in May 2006 at the University of Osnabrueck in Germany. Needless to say, the vision, dynamism and enthusiasm of Professor Helmut Lieth contributed greatly to the success of both scientific events.

‘Rehabilitation and sustainable use of mangrove and halophytic ecosystems in Venezuela’ has been one of the topics of these workshops. The state of the art in the knowledge of halophytic systems in Venezuela, the necessity of their conservation, the reclamation of soil affected by salinity and the possible strategies for their rehabilitation and sustainable use were discussed. Three projects were defined during the round table discussions: two for the coastal regions concerning the rehabilitation and sustainable use of mangrove ecosystems, and a third project for the inland, concerning the use of halophytes for the rehabilitation of soils affected by salinity as a consequence of using inadequate agricultural techniques. These projects were elaborated in collaboration with Professor Lieth, and adapted to the requirements of *Misión Ciencia* (an initiative of the Government of Venezuela in order to promote the development of science with emphasis on applied problems).

The projects for the coastal regions are the rehabilitation and creation of mangrove areas for their sustainable use in the sectors of Buche-Playa Los Totumos (Miranda State), Parque Nacional Morrocoy and the Vela de Coro (Falcón State), respectively. These three coastal sectors show evidence of inadequate environmental management. The laboratory of Ecology and

Genetics of Populations, the laboratory of Ecology of Soils of the Centre of Ecology of IVIC and the laboratory of Vegetation Ecology of the Central University of Venezuela will work on these projects in collaboration with the University of Osnabrueck. Specialists in the use of halophytes for conservation and management of saline ecosystems of other institutions are expected to contribute to these projects.

Some important benefits could be obtained from the realisation of these projects in the two regions of Venezuela. An increase of the mangrove areas could diminish the coastal erosion (which is important in the mentioned areas), and will improve the quality of air. Also an increase in complexity of the mangroves could favour the growing of species usually associated with these systems. This in turn could increase a sustainable fishery industry, which could favour the incoming population living in the neighbourhoods. From the social point of view these communities will be informed about conserving and producing benefits from mangroves in a sustainable way. Furthermore, these projects have an intrinsic scientific and teaching interest since the mentioned coastal regions can be considered as natural laboratories. Finally, educational tourism could also be an additional source of economical benefit.

The last project is addressed to the inland occidental central region of Venezuela. It concerns the use of halophytes for the rehabilitation of soils affected by salinity as a consequence of using inadequate agricultural techniques. Special attention will be given to the Valle de Quibor in Lara State. For the horticulture system in this valley, an excess of mechanisation and of saline water has been used. The farming of onions, tomatoes and melons are particularly extensive in this valley (about 5,000 ha).

This problem will be attacked in six steps:

1. Measures of the degree of salinity, quality of soils and water
2. Selection of the appropriate halophytes species
3. Pilot studies in farms
4. Chemical analysis to establish to which degree the halophytes are producing the expected result
5. Evaluation of the quality of the recuperated soils
6. Palatability proofs and protein efficiency of the halophytes to nourish livestock

I thank the participants of this workshop for giving me the opportunity to learn about the production of food and environmental conservation that can be useful for the Caribbean region.

Dr. Maximo Garcia Sucre, director IVIC
Aptdo. 21827 Caracas 1020-A
Venezuela

Table of Contents

Contributors

M.B. Barreto
Instituto Zoologia Tropical, Facultad de Ciencias, Universidad Central de Venezuela, Caracas, Venezuela, e-mail: manglerojo@gmail.com

A. Belligno
Department of Agricultural Engineering, University of Catania, Via Valdisavoia,
5 – 95123 Catania, Italy

B. Böer
UNESCO Regional Office in the Arabic State of Gulf, Doha, Qatar
e-mail: habitat_international@hotmail.com

S.S. Eisa
Ain Shams University, Faculty of Agriculture, Department of Agricultural Botany,
P.O. box 58 Hadayek Shobra, Cairo, Egypt,
e-mail: said_eisa@hotmail.com

M. García Sucre
Director del IVIC (Instituto Venezolano de Investigaciones Científicas), Caracas, Venezuela,
e-mail: mgs@ivic.ve

B. Herzog
OSTRin i.R Justinus-Kerner-Gymnasium,
74189 Weinsberg, Germany,
e-mail: brigitte.m.herzog@web.de

J. Hoek
Ocean Desert Enterprises,
Amsterdam, The Netherlands,
e-mail: jeannette@oceandesert.nl

H-W. Koyro
Justus-Liebig-University Giessen,
Institute for Plant Ecology, Heinrich-Buff-Ring
26-32, D-35392 Giessen, Germany,
e-mail: hans-werner.koyro@bot2.bio.uni-giessen.de

H. Lieth
Institute of Environmental Systems Research, University of Osnabrueck, D-49069 Osnabrueck, Germany,
e-mail: helmut.lieth@t-online.de

F. Pannier and R. Fraino de Pannier
Department of Biology, University of Merida, Merida, Venezuela,
e-mail: fpannier@hotmail.com

J.E. Paolini
Centro de Ecología, Instituto Venezolano de Investigaciones Científicas,
Apdo 21827, Caracas 1020-A, Venezuela,
e-mail: jpaolini@ivic.ve

J.P. Rodríguez
Centro de Ecología, Instituto Venezolano de Investigaciones Científicas, Apdo 21827, Caracas 1020-A, Venezuela, e-mail: jonpaul@ivic.ve

A Ruiz Castro
Centro de Ecología, Instituto Venezolano de Investigaciones Científicas, Apdo 21827, Caracas 1020-A, Venezuela, e-mail: augustoruizcastro@yahoo.com

L.E. Sánchez-Arias
Centro de Ecología, Instituto Venezolano de Investigaciones Científicas, Apdo 21827, Caracas 1020-A, Venezuela, e-mail: luchamangle@gmail.com

V. Sanz D'Angelo
Centro de Ecología Instituto Venezolano de Investigaciones Científicas, Apdo 21827, Caracas 1020-A Venezuela
e-mail: vsanz@ivic.ve

V. Sardo
Department of Agricultural Engineering, University of Catania, Via Valdisavoia, 5 – 95123 Catania, e-mail: sardo@mbox.fagr.unict.it

B.E. Vera Vegas
Centro de Botánica Tropical, Instituto de Biología Experimental, Universidad Central de Venezuela, Apdo 47114, Caracas, Venezuela, e-mail: beatrizesther.veravegas@gmail.com

List of Legends for the Colored Plates

The photos of the greenification with mangroves at the tourist centre near Pedrogonzales/Isla Margarita were all taken in 2006 by Sanz D'Angelo V. These photos show the present state of the mangroves planted originally by the team headed by Fraino de Pannier R and Pannier F (1988), (see Chapter 11 on page 109)

List of Tables

Color Plates

Several attendees used during the seminars some colored photos and figures. In the text of the 14 chapters we could use black and white copies only. Dr. Garcia Sucre allowed us therefore to add a selection of this special colored plate section. In this section we included pictures for which we assumed that the color improves significantly their value.

These figures belong to different papers. We kept for each figure the same figure Nr. and figure legend for both locations, in the chapters as well in the colored plates. In the figure Nr. refer the front digits before the decimal point to the chapter and the digits after the decimal point to the figure Nr. in the chapter. These figures appear in the colored plate section with Roman page Nr. and in the text of the chapters with Arabic page Nr. as shown in the table of contents and in the list of figures.

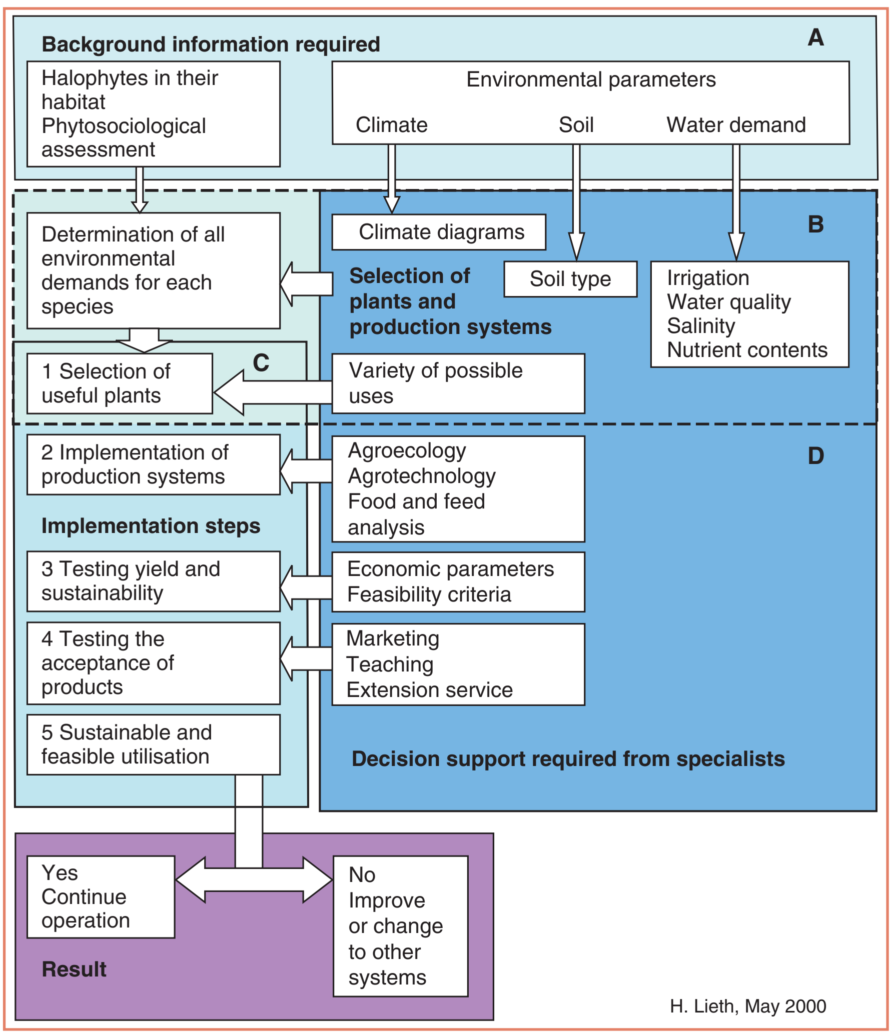

Fig. 1.1 Flow chart of work steps for the implementation of saline production systems (See p. 4)

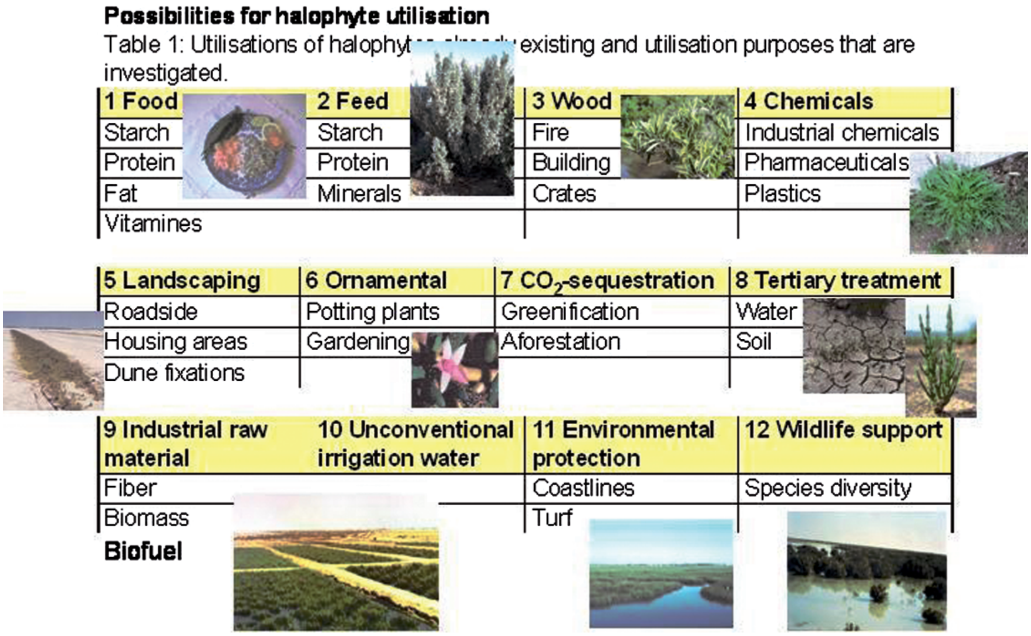

Fig. 2.1 Already existing halophyte utilisations and utilisation purposes that are under investigation (See p. 9)

Aster tripolium	A (µmol*m⁻²s⁻¹)	E (mmol*m⁻²s⁻¹)	WUE (A/E)	rs (m²*s*mol⁻¹)
control	24,30	3,81	6,58	3,21
	+3,14	+0,37	+1,25	+0,29
125NaCl	17,20	3,89	4,38	5,29
	+3,69	+0,58	+0,35	+0,55
375NaCl	7,88	2,10	3,76	42,33
	+2,22	+0,63	+0,50	+2,55
500NaCl	4,26	1,22	3,49	156,74
	+0,66	+0,47	+1,68	+13,64

Beta vulgaris ssp. *maritima*	A (µmol*m⁻²s⁻¹)	E (mmol*m⁻²s⁻¹)	WUE (A/E)	rs (m²*s*mol⁻¹)
control	2,79	1,82	1,53	6,44
	+0,22	+1,30	+0,69	+2,90
125NaCl	3,13	1,87	1,68	4,53
	+0,20	+0,64	+0,56	+1,24
375NaCl	2,90	1,17	2,47	9,67
	+0,10	+0,11	+0,17	+1,23
500NaCl	1,58	0,44	3,62	31,45
	+1,01	+0,27	+2,44	+16,73

Spartina townsendii	A (µmol*m⁻²s⁻¹)	E (mmol*m⁻²s⁻¹)	WUE (A/E)	rs (m²*s*mol⁻¹)
control	6,25	3,30	1,90	0,82
	±1,04	±0,20	±0,45	±0,20
125NaCl	8,17	3,17	2,57	1,46
	±1,01	±0,34	±2,34	±0,59
250NaCl	7,48	2,68	2,79	1,72
	±2,52	±0,21	±1,22	±0,32
375NaCl	7,25	2,29	3,17	2,49
	±2,26	±0,20	±1,31	±0,74
500NaCl	7,52	1,25	6,01	5,06
	±1,54	±0,26	±1,92	±1,99

Sesuvium portulacastrum	A (µmol*m⁻²s⁻¹)	E (mmol*m⁻²s⁻¹)	WUE (A/E)	rs (m²*s*mol⁻¹)
control	5,47	1,46	3,76	28,45
	+1,06	+0,20	+0,22	+4,88
125NaCl	6,53	1,67	3,90	26,40
	+0,25	+0,34	+0,34	+4,28
375NaCl	6,95	1,42	4,87	24,36
	+0,57	+0,02	+0,50	+0,28
500NaCl	7,44	1,51	4,98	22,60
	+0,81	+0,26	+0,36	+2,32

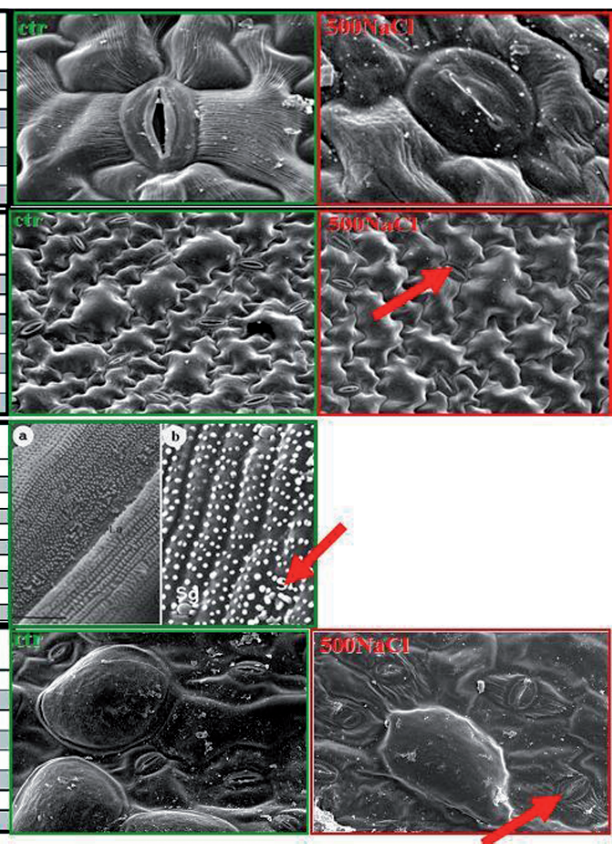

Fig. 2.6 Influence of NaCl salinity on the apparent photosynthesis (A), the adaxial transpiration (E), the water use efficiency (WUE) and the stomatal conductance (rs) of *Aster tripolium*, *Beta vulgaris* ssp. *maritima*, *Spartina townsendii* and *Sesuvium portulacastrum*. The ultrastructures (SEM-micrograph) of the leaf surfaces (left side controls, right side seawater salinity treatments) are presented next to the responding table (See p. 14)

Fig. 3.1 On the picture one can see that the *Rhizophora* is dying on some branches. This is caused by speed boats coming too close to the stilting roots of these trees at low tide (See p. 22)

Fig. 3.2 *Thalassia* stand covered with fine sand which was taken from the bottom which can be seen on the left. Fast going speed boats with tourists disturb the sand and put it over the *Thalassia* (See p. 22)