

Contents

1 The Aralkum, a Man-Made Desert on the Desiccated Floor of the Aral Sea (Central Asia): General Introduction and Aims of the Book	1
S.-W. Breckle and W. Wucherer	
References	8

Part A Abiotic Conditions and Dynamics

2 Dynamics of the Aral Sea in Geological and Historical Times	13
S.-W. Breckle and G.V. Geldyeva	
2.1 Introduction	13
2.2 Geology and Tectonics in the Aral Basin in the Tertiary and Quaternary	14
2.3 Geological and Historical Dynamics of the Aral Sea Before 1960 ...	16
2.4 Regression of the Aral Sea After 1960 and Hydrological Conditions	24
2.4.1 Hydrology and Water Use	24
2.4.2 South Aral Sea	26
2.4.3 North Aral Sea	27
2.5 Formation of the Aralkum	28
2.5.1 Dynamics of the Aralkum	29
2.6 Conclusions	31
References	33
3 Geography and Geomorphological and Lithological Characteristics of the Aralkum	37
G.V. Gel'dyeva, S.-W. Breckle, and B.V. Gel'dyev	
3.1 Introduction	37
3.2 Geology and Tectonic Processes	37
3.3 Sedimental Deposits on the Dry Desiccated Seafloor	38

3.4	Geomorphological Structure	40
3.5	Formation of the New Continental Plain (Dry Seafloor: Aralkum) ...	43
3.6	Delta Areas of the Dry Seafloor	47
3.7	Conclusions	47
	References	47
4	Climatic Conditions in the Aralkum	49
	S.-W. Breckle and W. Wucherer	
4.1	Introduction	49
4.2	General Characteristics	51
4.3	Methods and Database	52
4.4	Climatic Parameters	52
4.4.1	Radiation	52
4.4.2	Temperature	56
4.4.3	Precipitation	59
4.4.4	Humidity	63
4.4.5	Evaporation	65
4.4.6	Wind	65
4.5	Climatic Zonation and Climatic Regions	66
4.5.1	General Remarks	66
4.5.2	Aralkum: Aralsk Subdistrict (Northern Turanian or Kazakh-Dzungarian Deserts)	67
4.5.3	Aralkum: Muinak Subdistrict (Southern Turanian Deserts) ...	67
4.6	Conclusions: Aridization and Climate Change?	69
	References	71
5	Dust Storms and Sandstorms and Aerosol Long-Distance Transport	73
	O.E. Semenov	
5.1	Introduction	73
5.2	General Remarks	73
5.3	Frequency of Storms	74
5.4	Mass Transport by Storms	74
5.5	Conclusions	81
	References	82
6	Landscape Dynamics in the Southern Aralkum: Using MODIS Time Series for Land Cover Change Analysis	83
	F. Löw, P. Navratil, and O. Bubenzer	
6.1	Introduction	83
6.2	Study Objectives	84
6.3	Study Area	85
6.4	Characterization of Land Cover Classes in the Study Area	86
6.5	Data and Methods	88

6.6 Results 90

 6.6.1 Landscape Dynamics Between 2000 and 2008 90

 6.6.2 Ecosystem Dynamics 93

6.7 Conclusions 95

References 95

7 Dynamics of Dust Transfer from the Desiccated Aral Sea

Bottom Analysed by Remote Sensing 97

L. Spivak, A. Terechov, I. Vitkovskaya, M. Batyrbayeva, and L. Orlovsky

7.1 Introduction 97

7.2 Satellite Monitoring of the Aral Sea Area 97

7.3 Space Monitoring of Dust Storms 98

7.4 Technique for Defining the Dust Aerosol Transfer Zone 100

7.5 Investigation of the Dynamics of the Zone of Aerosol
Removal in the Eastern Part of the Aral Sea 101

7.6 Frequency of Dust Storms 104

7.7 Conclusions 104

References 106

Part B Biotic Aspects and Ecosystems Dynamics

8 Flora of the Aralkum 109

L.A. Dimeyeva, S.-W. Breckle, and W. Wucherer

8.1 Introduction 109

8.2 History of Floristic Studies 110

8.3 Composition of the Flora 111

8.4 Life Form Spectrum 111

8.5 Geographical Analysis of the Flora 122

8.6 Conclusions 124

References 125

9 Vegetation of the Aralkum 127

S.-W. Breckle, W. Wucherer, and L.A. Dimeyeva

9.1 Introduction 127

9.2 Zonal Vegetation and Main Vegetation Types
at the Former Coastline 128

9.3 Characteristics of the Vegetation Distribution in the Aralkum 129

9.4 Main Vegetation Types in the Aralkum 139

 9.4.1 Psammophytic Vegetation 139

 9.4.2 Halophytic Vegetation 141

 9.4.3 Tugai Vegetation 144

 9.4.4 Salt Meadows 145

- 9.5 Phytogeographical Zonation 145
 - 9.5.1 General Remarks 145
 - 9.5.2 Botanical-Geographical Status of the Aralkum 148
 - 9.5.3 Vegetation Districts of Ancient Marine Terraces
of the Aral Sea 150
 - 9.5.4 Vegetation Districts of the Former Seafloor (Aralkum) 152
- 9.6 Human Impact on Vegetation 155
- 9.7 Conclusions 156
- References 157

- 10 Primary Succession in the Aralkum 161**
 W. Wucherer, S.-W. Breckle, and A. Buras
 - 10.1 Introduction 161
 - 10.2 Methods and Data Collection 162
 - 10.3 Results 164
 - 10.3.1 Observations on the Permanent Plots on the Bayan
Transect 164
 - 10.3.2 Chronosequences of the Psammophytic Plant
Communities 175
 - 10.3.3 Spreading Out and Distribution of Pioneer Species
Around the Small Aral Sea 184
 - 10.4 Discussion 186
 - 10.4.1 Halophyte Succession on the Dry Seafloor 186
 - 10.4.2 Psammophyte Succession on the Dry Seafloor 189
 - 10.4.3 Factors Influencing Primary Succession in the Aralkum ... 193
 - 10.5 Conclusions 196
 - References 197

- 11 Fauna of the Aralkum 199**
 U. Joger, T. Dujsebayaeva, O.V. Belyalov, Y. Chikin, D. Guicking,
 Y.A. Grachev, R. Kadyrbekov, and C. Miaud
 - 11.1 Introduction 199
 - 11.2 Vertebrates 199
 - 11.2.1 Mammals 200
 - 11.2.2 Birds of the Kazakhstan Part of the Aral Sea Basin 205
 - 11.2.3 Reptiles 215
 - 11.2.4 Amphibians 222
 - 11.3 Insects of the Kazakhstan Part of the Aral Sea Region 223
 - 11.3.1 Taxonomic Diversity of the Insects of the
Aral Sea Basin 224
 - 11.4 Faunistic Invasions 231
 - 11.4.1 Succession of Reptiles, Amphibians and Insects 231
 - 11.4.2 On Settling by Reptiles of the New Land Bridge
Between the Former Island of Barsa-Kelmes
and the Eastern Coast of the Aral Sea 238

11.4.3	Succession of Mammals on the Dried Sea Bottom	240
11.4.4	Birds Occupying the Dried Bottom	241
11.4.5	General Conclusions	243
11.5	Zoogeographical Aspects	244
11.5.1	Zoogeographical and Ecological Characteristics of Aral Sea Mammals	244
11.5.2	Biogeography of the Birds of the Aral Sea Basin	247
11.5.3	General Biogeography of Reptiles	249
11.5.4	Phylogeography of the Dice Snake <i>Natrix tessellata</i>	249
11.5.5	Phylogeography of Desert Runners (<i>Eremias</i> spp.)	255
11.5.6	Biogeography of Aral Region Insects	255
11.6	Nature Conservation	257
11.7	Conclusions	258
	References	259
12	Halophytes and Salt Desertification in the Aralkum Area	271
	S.-W. Breckle and W. Wucherer	
12.1	Introduction	271
12.1.1	Halophyte Groups	273
12.1.2	Ion Pattern of Halophytes	276
12.1.3	Ecological Salinity Indicator Values for Plants of the Aralkum Region	283
12.1.4	Salinity	285
12.2	Conclusions	295
	References	297
13	Spatial Distribution of Plant Functional Types Along Stress Gradients – A Simulation Study Orientated Towards the Plant Succession on the Desiccating Aral Sea Floor	301
	J. Groeneveld, W. Wucherer, L.A. Dimeyeva, F. Jeltsch, C. Wissel, and S.-W. Breckle	
13.1	Introduction	301
13.2	Methods of Investigation – Model Description	302
13.2.1	General Structure	302
13.2.2	Abiotic Conditions	303
13.2.3	Biotic Processes	304
13.3	Simulation Experiments and Results	306
13.3.1	Results for the First Scenario: Global Nonspatial Seed Bank	307
13.3.2	Results for the Second Scenario: Local Dispersal	307
13.3.3	Results for the Third Scenario: High Spatial Variability of Stress Conditions	308
13.4	Discussion	308
	References	310

Part C Means of Present and Future Development

14 Nature Conservation in the Aral Sea Region: Barsa-Kelmes as an Example	315
L.A. Dimeyeva, N.P. Ogar, Z. Alimbetova, and S.-W. Breckle	
14.1 General Aspects	315
14.2 Barsa-Kelmes Nature Reserve	316
14.2.1 General Information	316
14.2.2 Flora	318
14.2.3 Vegetation Cover of Barsa-Kelmes	319
14.3 Fauna of Barsa-Kelmes	332
14.3.1 Invertebrates	332
14.3.2 Vertebrates	332
14.4 Vegetation of the Kaskakulan Area	334
14.5 Perspectives of Protected Area Development	335
14.5.1 Importance of Protecting Ecosystems	335
14.5.2 Necessities for Conservation	336
14.5.3 Means of Protection and Political Actions	337
14.6 Conclusions	339
References	340
15 Phytomelioration in the Northern Aralkum	343
W. Wucherer, S.-W. Breckle, V.S. Kaverin, L.A. Dimeyeva, and K. Zhamantikov	
15.1 Introduction	343
15.2 Experiments of the Institute of Forest Economy of Kokchetav on the Kaskakulan Transect	344
15.2.1 Experimental Plots and Results of Plantings	346
15.2.2 Growth Rates	354
15.2.3 Technology for the Stabilization of Barchans	357
15.3 Combating Desertification and Rehabilitation of the Salt Deserts on the Desiccated Seafloor	359
15.3.1 Reforestation Potential of Sandy and Salty Sites and Habitat Conditions	359
15.3.2 Methodical Approach	362
15.3.3 <i>Haloxylon aphyllum</i> Plantings on Different Sites	364
15.3.4 <i>Halocnemum strobilaceum</i> Plantings	373
15.3.5 <i>Tamarix</i> Plantings	375
15.3.6 Physicochemical Properties of Saline Soils on Planting Plots	375
15.4 Shelterbelts for Villages	377
15.5 Perspectives and Necessity of Phytomelioration on the Desiccated Seafloor	378

15.5.1	Minicatchment Experimental Sets on the Bayan Transect at the Eastern Coast	378
15.5.2	Results of the Plantings in the Kushzhitmes Area	379
15.5.3	Phytomelioration Properties of <i>Haloxylon aphyllum</i>	380
15.5.4	Development of New Planting Strategies	381
15.6	Discussion and Final Conclusions	383
	References	384
16	Phytomelioration in the Southern Aralkum	387
	Z.B. Novitskiy	
16.1	Introduction	387
16.2	The Present Critical Situation	388
16.3	Aims of the Project	389
16.4	The Recent History of Phytomeliorative Plantations	390
16.5	Melioration Project	391
16.5.1	Necessary Preconditions	391
16.5.2	Effects of Wind Conditions and Planting Results	392
16.5.3	Projects of Plantings	397
16.5.4	Project Sectors	399
16.6	Conclusions	405
	References	406
17	Phytomelioration of Solonchanks in the Uzbekistan Pre-Aral Region Under Recent Climate Change	407
	Zh.V. Kuzmina and S.Ye. Treshkin	
17.1	Introduction	407
17.2	Analysis of Recent Climate Changes in the Pre-Aral Region	409
17.3	Microclimatic Conditions for Experimental Plantations According to Data Obtained by Device Recorders	416
17.4	Location of Test Areas	420
17.5	Planting Technology	420
17.6	Watering	421
17.7	The Main Results from Plantations	421
17.8	Main Conclusions	427
	References	428
18	The Aralkum Situation Under Climate Change Related to Its Broader Regional Context	431
	G. Winckler, E. Kleinn, and S.-W. Breckle	
18.1	The Background of Desertification and Land Degradation in the Central Asian Region	431
18.1.1	The Underlying Problem: The Dimension and Consequences of Land Degradation	431
18.1.2	All Countries in Central Asia Face Similar Challenges ..	437

18.2 Climate Change and Land Use Development in the Central Asian Region	438
18.2.1 Climate Change Scenarios and Predictions	438
18.2.2 Potential Consequences of Climate Change in Central Asia	439
18.2.3 Priority to Stabilize Agricultural Production	440
18.3 International Treaties Governing Land Management, Biodiversity and Climate Change in Central Asia	441
18.4 The Role of Science in Combating Desertification and Improving Land Management in Central Asia	443
18.4.1 Scientific Potential of the Area	443
18.4.2 Barsa-Kelmes: An Example for a Strategic Change in Nature Protection in the Aralkum Region	446
18.4.3 Desertification, Water Supply and Energy Supply	448
18.5 Main Challenges for Sustainable Land Management in the Central Asian Region	451
18.5.1 Three Big Basic Challenges	451
18.5.2 Adaptation Strategies	452
18.6 Conclusions	454
References	455

Part D Conclusions

19 The Aralkum, a Man-Made Desert on the Desiccated Floor of the Aral Sea (Central Asia): Final Conclusions and Comments	459
S.-W. Breckle and W. Wucherer	
References	464
Subject Index	465
Taxonomic Index	481



<http://www.springer.com/978-3-642-21116-4>

Aralkum - a Man-Made Desert

The Desiccated Floor of the Aral Sea (Central Asia)

Breckle, S.-W.; Wucherer, W.; Dimeyeva, L.A.; Ogar, N.P.

(Eds.)

2012, XXIV, 488 p., Hardcover

ISBN: 978-3-642-21116-4