A continental landscape framework for systematic conservation planning for Australian rivers and streams

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I certify that unless otherwise acknowledged this thesis is my own original work. It includes material also published in the Proceedings of the Fourth Australian Stream Management Conference (Stein, 2005) and a report to Land and Water Australia (Kingsford et al., 2005).
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Abstract

Conservation of Australia’s distinctive river ecosystems has lagged behind that of terrestrial and marine environments despite mounting evidence of the destructive effects of human activities. There has been little nationally coordinated conservation activity. A systematic, continent-wide conservation planning approach would ensure limited conservation resources are allocated efficiently and decisions are accountable. This thesis addresses critical gaps in the spatial data required for systematic conservation planning. It describes the development of a stream network and nested catchment reference system to provide the spatial framework. This framework, at a map scale of approximately 1:250,000, supplies planning units for application of reserve design algorithms and determination of priorities for protective management as well as units for reporting conservation evaluation and assessment. The Pfafstetter coding of the catchment units identifies drainage network connectivities allowing them to be readily incorporated into conservation planning procedures.

This thesis presents for the first time a comprehensive picture of continent-wide variation in the landscape factors that ultimately control riverine ecosystem patterns and processes. Stream segments, the section of the stream between tributary confluences and the smallest unit in the spatial framework, have been individually characterized and classified at multiple scales using attributes that describe the catchment (and/or sub-catchment) climate, water balance, geology, terrain and vegetation. Segments were clustered according to their similarity in environmental data space so that, unlike ecoregion classifications, groups may be geographically dispersed. The resulting River Environment Types have been found to differentiate significant variation in stream biota (macroinvertebrates and fish) and habitat characteristics. However, classification strength varies widely among types. It is hypothesised that this is due to both classification uncertainty and limitations of the test data.

The spatial framework and classifications are the central elements of a continental landscape framework that could be used to support systematic conservation planning and assist the development of a national conservation plan for Australia’s rivers and streams. The framework could also provide the basis for an online information system to serve a broader range of NRM planning and management objectives. The utility of the continental framework has been demonstrated in a review of the National Reserve System (NRS). The review acknowledges some uncertainty in the results due to inaccuracies and limitations of the framework, but nevertheless, concludes that the NRS must be expanded if it is to achieve a comprehensive and adequate protected area system for river ecosystems.
This study makes major contributions to spatial analysis methodology. It has developed and applied a new method of drainage analysis applicable to diverse drainage structures at continental scale and recommends enhancements to the internationally adopted Pfafstetter scheme. It also advances understanding of the role for landscape classification and the influence of classification choice on conservation planning outcomes. The development of the continental landscape framework for Australia presents a model and the necessary tools for conservation planning for the rivers and streams of other continents.
Contents

Acknowledgements ........................................................................................................ i

Abstract .......................................................................................................................... iii

Contents ............................................................................................................................ v

List of Tables ...................................................................................................................... ix

List of Figures .................................................................................................................... xi

List of Abbreviations ......................................................................................................... xv

Chapter 1. Introduction ....................................................................................................... 1

1.1. Australian rivers and streams ...................................................................................... 1

1.2. The distinctive character of Australian streams ......................................................... 3

1.3. The conservation imperative ....................................................................................... 5

1.4. Conservation initiatives ............................................................................................... 7

1.5. Developing a conservation plan for Australian rivers and streams .......................... 10

1.5.1. A continental perspective ......................................................................................... 10

1.5.2. Systematic conservation planning ........................................................................ 11

1.5.3. An ecosystems approach ......................................................................................... 14

1.6. A continental landscape framework to support systematic conservation planning 14

1.6.1. Research aims ......................................................................................................... 15

1.6.2. Scope ....................................................................................................................... 15

1.6.3. Thesis structure ...................................................................................................... 15

Chapter 2. Defining a spatial framework ........................................................................... 19

2.1. Spatial frameworks and conservation planning .......................................................... 19

2.2. Choosing a spatial framework ................................................................................... 22

2.2.1. Scale ....................................................................................................................... 23

2.2.2. Type and configuration of spatial units .................................................................. 25

2.3. A spatial framework for rivers and streams ............................................................... 25

2.4. Conclusions ............................................................................................................... 29

Chapter 3. Continental scale catchment frameworks ...................................................... 31
3.1. Existing catchment frameworks for Australian rivers and streams 31

3.2. Delineating a new catchment framework 34
   3.2.1. Drainage analysis of a DEM 34
   3.2.2. Hierarchical catchment reference systems 43

3.3. Conclusions 46

Chapter 4. A new method of drainage analysis and its application 47

4.1. Introducing a new method of drainage analysis 47
   4.1.1. Step 1: DEM preparation 48
   4.1.2. Step 2: Channel initiation 48
   4.1.3. Steps 3 and 4: Distributary and uncoordinated drainage structures 49
   4.1.4. Step 5: Delineating catchments 51

4.2. Applying the new method 52
   4.2.1. Supporting data layers and critical functions 54
   4.2.2. Delineating a stream network 62
   4.2.3. Validating the drainage analysis 66

4.3. Results 69
   4.3.1. Stream network 69
   4.3.2. Validation 72

4.4. Discussion 77
   4.4.1. Drainage analysis procedures 77
   4.4.2. Drainage analysis of the Australian DEM 79
   4.4.3. Validation 79

4.5. Conclusions 81

Chapter 5. A nested catchment framework 83

5.1. Methods 83
   5.1.1. Delineating drainage basins 83
   5.1.2. Aggregating small basins 84
   5.1.3. Implementing the Pfafstetter system 85

5.2. Results 91
   5.2.1. Drainage basins 91
   5.2.2. Nested catchments 96

5.3. Discussion 99
   5.3.1. A new nested catchment reference system 99
   5.3.2. The Pfafstetter system 101
5.4. Conclusions ......................................................... 103

Chapter 6. River classification: a review ............................................ 107

6.1. Classification approaches .................................................. 108
6.2. Biological classification ...................................................... 110
6.3. Habitat classification ......................................................... 113
6.4. Landscape classification ...................................................... 118
6.5. Conclusions ........................................................................ 122

Chapter 7. Landscape classification of Australian rivers and streams .......... 123

7.1. Guiding principles ............................................................. 123
7.2. Methods ............................................................................ 125
  7.2.1. Classificatory strategy .................................................... 125
  7.2.2. Classifying Australian rivers and streams ......................... 128
  7.2.3. Evaluating the classifications .......................................... 143
7.3. Results .............................................................................. 145
  7.3.1. River Environment Types ............................................... 145
  7.3.2. Combining hierarchical levels ......................................... 170
  7.3.3. Numbers of groups ....................................................... 171
7.4. Discussion .......................................................................... 172
  7.4.1. Classification approach .................................................. 174
  7.4.2. Systematic conservation planning requirements ............... 174
  7.4.3. Opportunities for improvement ....................................... 175
7.5. Conclusions ........................................................................ 181

Chapter 8. Are the landscape classifications ecologically relevant? ........ 183

8.1. Methods ............................................................................. 183
  8.1.1. Test data ......................................................................... 183
  8.1.2. Linking classifications and survey sites ............................. 191
  8.1.3. Evaluating ecological relevance ...................................... 192
8.2. Results .............................................................................. 195
  8.2.1. Biotic similarity .............................................................. 195
  8.2.2. Stream habitat descriptors ............................................. 203
  8.2.3. Northern Territory river habitat survey ............................ 207
8.3. Discussion .......................................................................... 211
8.3.1. Comparing classifications ........................................ 212
8.3.2. Comparison with other studies .................................. 213
8.3.3. Variability in the strength of individual groups ................. 215

8.4. Conclusions .................................................................. 217

Chapter 9. Reviewing the National Reserve System .................. 221

9.1. Methods ..................................................................... 222
9.1.1. The National Reserve System .................................... 222
9.1.2. Indices of anthropogenic disturbance ......................... 224
9.1.3. Conservation Targets ............................................. 228
9.1.4. Evaluating the National Reserve System .................... 231

9.2. Results ....................................................................... 232
9.2.1. Protected streams and basins .................................... 232
9.2.2. Comprehensiveness and adequacy of the National Reserve System ...................................................... 235

9.3. Discussion ................................................................... 241
9.3.1. Comprehensiveness and adequacy .............................. 241
9.3.2. Assessment reliability ............................................. 242
9.3.3. Classification choice .............................................. 243

9.4. Conclusions .................................................................. 244

Chapter 10. Outcomes and conclusions ................................. 245

10.1. A continental landscape framework for Australian rivers and streams ................................................................. 245
10.1.1. Systematic conservation planning applications ............ 245
10.1.2. Other applications ................................................. 250

10.2. Spatial data uncertainty ............................................... 251
10.2.1. Planning with uncertainty ....................................... 252
10.2.2. Reducing uncertainty .......................................... 253

10.3. Contribution to methodology ....................................... 255

10.4. Conclusions ............................................................... 256

References ........................................................................ 257

Appendix 1 Separating valley floors from hillslopes: the Flatness Index ................................................................. 297
Appendix 2 Comparing the catchment water balance with observed flow ................................................................. 299
Appendix 3 Membership of ALL meta-groups .......................... 303
Appendix 4 Field data sheets ............................................... 305
List of Tables

Table 2.1 A nested hierarchy of spatial units comprising a drainage basin. 27
Table 3.1 Systems for delineation and/or codification of topographically defined hydrologic units at national scales 44
Table 4.1. Source data for the 9-second DEM 56
Table 4.2. Summary statistics for the 9-second DEM-derived stream network 71
Table 4.3. Coincidence of the 9-second DEM-derived stream network and gridded GEODATA TOPO 250K 1:250,000 scale streamlines 75
Table 4.4 Coincidence of the 9-second DEM-derived stream network and gridded reference streams in the Cotter River catchment 75
Table 4.5. Cotter River catchment total stream length 75
Table 4.6. Proportion of the 9-second DEM-derived catchment boundary length within the buffer distance of the reference catchment boundary 76
Table 5.1 Australia’s largest drainage basins 92
Table 5.2 Number of basin units remaining after aggregation 93
Table 5.3 Properties of the 9 level Pfafstetter sub-divisions 97
Table 7.1 Landscape attributes used to classify rivers 127
Table 7.2 Climatic attributes used to classify stream segments 131
Table 7.3 Classes of percentage of clay used to assign GROWEST soil texture category 133
Table 7.4 Catchment water balance attributes used to classify stream segments 134
Table 7.5 Lithological classes defined by Nix et al. (1992) by numerical clustering of map units on the digital version of the 1976 Edition of Geology of Australia 136
Table 7.6 Surficial cover categories from the digital version of the 1976 Edition of Geology of Australia 137
Table 7.7 Terrain attributes used to classify stream segments 138
Table 7.8 Attribute sets used to generate each classification 142
Table 7.9 The ten vegetation groups formed from the combination of the National Vegetation Information System (NVIS) major vegetation classes 143
Table 7.10 The climate classification groups 146
Table 7.11 The flow classification groups 156
Table 7.12 The terrain classification groups 157
Table 7.13 Kruskal-Wallis rank sum statistics 164
Table 7.14 Group means for closest groups 165
Table 7.15 Summary properties of the classifications of River Environment Types 171
Table 7.16 Correspondence between Level 1 (Climate) groups and the agroclimatic classification of Hutchinson and colleagues 173
Table 8.1 Site variables extracted from the AusRivAS database 188
Table 8.2 Northern Territory river habitat survey sites 190
Table 8.3 Classification strength of landscape classifications evaluated using fish community composition at sites from the NSW Rivers Survey database

Table 8.4 Classification strength of landscape classifications evaluated using macroinvertebrate community composition at sites from the AusRivAS database

Table 8.5 Number of variables for which the landscape classification is judged to provide the best fit or is ranked among the best three models

Table 8.6 Summary of mixed effect models for AusRivAS site variables

Table 8.7 Number of Northern Territory river survey sites by floodplain occurrence with ALL classification group

Table 8.8 Summary of classification strength results for landscape classifications from international studies adopting comparable methods

Table 9.1. IUCN guidelines for protected area management categories

Table 9.2 Computed conservation targets for River Environment Types by classification

Table 9.3 Length of streams within protected areas by IUCN category and relative size as indicated by the stream name

Table 9.4 The 20 largest named streams with protected upper catchments within an IUCN protected area class I to IV and no major instream barriers

Table 9.5 Fully protected drainage basins

Table 9.6 Replication of River Environment Types within the National Reserve System

Table 9.7 Numbers of rare and threatened River Environment Types and their representation within the National Reserve System

Table 9.8 Numbers of River Environment Types where remaining unprotected and undisturbed stream length is insufficient to achieve the conservation target

Table 10.1 A continental landscape framework for Australia’s rivers and streams: compliance with the target setting principles established for the National Reserve System

Table 10.2 Sources of spatial data uncertainty

Table A.1 Flatness Index class definition and abundance
List of Figures

Figure 1.1. Locality map showing State and Territory borders and major rivers. 2
Figure 2.1. The hierarchical organization of a stream system 26
Figure 3.1 The Australian Water Resources Council (AWRC) Drainage Divisions and Basins 32
Figure 3.2. Sub-catchments from the nested catchments layer defined for the NLWRA using a contributing area threshold of 2.5km² 33
Figure 3.3. Streamlines from the GEODATA TOPO 250K database version 1 for the area around Sydney. 35
Figure 3.4. The D8 method of determining flow direction. 36
Figure 3.5. Delineating a stream network by application of a contributing area threshold. 37
Figure 4.1. Delineating a stream network step 2: identifying channel heads from mapped streamlines and tracing flow pathways. 49
Figure 4.2. Delineating a stream network step 3: adding major anabranches. 50
Figure 4.3 Delineating a stream network step 4: removing stream segments greater than a threshold flow path distance to a mapped streamline 51
Figure 4.4 Developing a new stream and catchment reference system for Australia. 53
Figure 4.5. The 9 second DEM version 2.1. 55
Figure 4.6. Flow direction codes. 57
Figure 4.7 Correcting flow directions to remove crossing flow paths and sub-catchment tails 58
Figure 4.8. Segment pour-points 61
Figure 4.9. Alternative specification of channel heads where the gridded from node of the map streamline arc is captured by the flow path of another stream. 63
Figure 4.10 Adding flow directions at major flow bifurcations. 64
Figure 4.11. Masking the stream network to remove source channels with a contributing area smaller than is reproducible from the 9 second DEM 65
Figure 4.12. The NLWRA streamflow gauging stations used as a reference set to test the accuracy of the DEM-derived catchment areas 67
Figure 4.13. The Cotter River Catchment in southern ACT. 69
Figure 4.14 The 9-second DEM-derived stream network for the Sydney region. 70
Figure 4.15 Laws of drainage network composition: properties of the derived stream network with stream order. 71
Figure 4.16 Flow bifurcations coded into the flow direction grid 72
Figure 4.17. Comparison of DEM-derived and reference areas for catchments of the NLWRA extended flow series gauging stations. 73
Figure 4.18 DEM-derived streamlines with mapped streamlines from the 1:250,000 scale GEODATA TOPO 250K database and NSW 1:25,000 scale topographic mapping. 74
Figure 4.19. Comparison of the Cotter River catchment boundaries delineated from the 9-second DEM and 5m ALS DEM 76
Figure 4.20 Comparison of Cotter River segment sub-catchment boundaries.

Figure 5.1 Aggregating small closed basins for assignment of Pfafstetter codes and identification of broad scale topographic structure.  
Figure 5.2 Pfafstetter Level 1 sub-division of the Australia continent  
Figure 5.3 Pfafstetter sub-division of a coastal inter-basin (Level 1 inter-basin 5)  
Figure 5.4 Pfafstetter sub-division of a basin: Fitzroy River basin (Level 1 basin 4)  
Figure 5.5 Pfafstetter sub-division of an inter-basin: the Nogoa River sub-catchment (Level 2 inter-basin 49) of the Fitzroy River basin (Level 1 basin 4)  
Figure 5.6 Treating the multiple channels of distributary channel systems as a single tributary unit Yergemont Creek and Thomson River confluence, Lake Eyre Basin.  
Figure 5.7 Drainage classes  
Figure 5.8. The topographically defined drainage basins of Australia delineated by drainage analysis of the 9 second DEM  
Figure 5.9 Improved placement of drainage divides: basin boundaries delineated by this study for the Burnett and Mary River (Queensland) with recent versions of the AWRC basins; Australia’s River Basins and Surface Water Management Areas compiled for the NLWRA  
Figure 5.10 Comparison of drainage basins derived in this study and AWRC: effect of catchment outlet choice  
Figure 5.11 Level 2 Pfafstetter sub-division of the Burdekin River basin, Queensland: tributary-main stems differentiated according to a) contributing area and b) catchment water balance.  
Figure 5.12 Extracting catchment units of a consistent area from the Pfafstetter nested catchment hierarchy  
Figure 5.13 Using the Pfafstetter codes to infer the influence of a hypothetical new dam.  
Figure 6.1 Riverine Biological Regions of Victoria (after Doeg, 2001)  
Figure 6.2 The River Environment Classification (REC) – controlling factors and characteristic spatial scales (after Snelder, Biggs et al., 2004)  
Figure 6.3 Environmental domains of Papua New Guinea used as biodiversity surrogates to identify priority areas for conservation (after Nix et al., 2000).  
Figure 7.1 Developing a landscape classification for Australian rivers and streams.  
Figure 7.2 Climatic attributes used to classify stream segments.  
Figure 7.3 Stream segment pour-point values of the “flow” attributes derived from the modelled catchment water balance and used to classify stream segments  
Figure 7.4 Stream segment values of terrain attributes used to classify stream segments  
Figure 7.5 The climate classification: stream segments classified by climatic attributes statistics.  
Figure 7.6 The flow classification: stream segments classified by modelled catchment water balance  
Figure 7.7 The geology classification: stream segments classified by dominant lithological group in the segment sub-catchment  
Figure 7.8 The terrain classification: stream segments classified by terrain attributes
Figure 7.9 The vegetation classification: stream segments classified by dominant vegetation group in the segment sub-catchment

Figure 7.10 The ALL classification: stream segments classified by climate, flow, terrain and geology attributes.

Figure 7.11 Boxplots showing the distribution of climate attribute values among the 10 groups of the climate classification.

Figure 7.12 Boxplots showing the distribution of catchment water balance attribute values among the 10 groups of the flow classification.

Figure 7.13 Boxplots showing the distribution of terrain attribute values among the 10 groups of the terrain classification.

Figure 7.14 Boxplots showing the distribution of values of the climate and flow attributes with the highest Kruskal-Wallis statistic among the groups of the ALL classification.

Figure 7.15 Relationship among climate groups

Figure 7.16 Relationship among flow groups

Figure 7.17 Relationship among terrain groups

Figure 7.18 Relationship among the ALL groups

Figure 7.19 Comparison of the average deviation and modified classification strength for alternative numbers of groups for climate, flow and terrain classifications.

Figure 8.1 Distribution of sites in the NSW Rivers Survey.

Figure 8.2 Distribution of AusRivAS sites.

Figure 8.3 Distribution of macroinvertebrate count values showing effect of different data transformations.

Figure 8.4 Number of taxa recorded for edge and riffle habitats at AusRivAS sites with sampling method.

Figure 8.5 Location of Northern Territory survey sites.

Figure 8.6 Mean similarity dendrograms for fish species presence/absence and average catch for the hierarchical river environment classifications.

Figure 8.7 Mean similarity dendrograms for fish species presence/absence and average catch for the ALL stream landscape classification, IBRA regions and sub-regions and topographically defined drainage basins.

Figure 8.8 Mean similarity dendrograms for macroinvertebrate taxa presence/absence for the hierarchical river environment classifications.

Figure 8.9 Mean similarity dendrograms for macroinvertebrate taxa presence/absence for the ALL river environment classification, IBRA regions and sub-regions and topographically defined drainage basins.

Figure 8.10 Bayesian Information Criterion (BIC) values by classification for each of the AusRivAS site variable mixed models.

Figure 8.11 Akaike Information Criterion (AIC) values by classification for each of the AusRivAS site variable mixed models.

Figure 8.12 Northern Territory survey sites with Level 5 River Environment Type
Figure 8.13 Cattle grazing, Playford River

Figure 8.14 Boxplots for selected attributes with Level 2 River Environment Types for Northern Territory survey sites.

Figure 8.15 Average River Disturbance Index (RDI) values with NSW Rivers Survey presence/absence mean within group similarities (W) for Level 5 and ALL River Environment Types.

Figure 9.1 The National Reserve System (CAPAD 2002)

Figure 9.2 The River Disturbance Model used to derive indices of anthropogenic disturbance

Figure 9.3 Developing the river disturbance database

Figure 9.4 River Disturbance Index (RDI) values

Figure 9.5 Protected rivers and stream

Figure 9.6 Proportion of topographically defined drainage basin contained within an IUCN category I to IV protected area.

Figure 9.7 Proportion of stream length within an IUCN category I to IV protected area by River Environment Types computed for each of the levels in the hierarchical and the combined (ALL) classification

Figure 9.8 Progress towards conservation targets: length of stream within an IUCN category I to IV protected area as a percentage of target length for ALL and Level 5 River Environment Types

Figure 9.9 Proportion of remaining undisturbed (RDI < 0.05) and unprotected stream required to achieve conservation targets for ALL and Level 5 River Environment Types

Figure 9.10 Priority streams for conservation action: more than 90% of the remaining undisturbed streams are required to achieve conservation targets for River Environment Types

Figure A.1 Separating valley floors from hillslopes: Flatness Index Classes

Figure A.2 Log-log plots of catchment water balance with observed flow summary statistics for gauging stations assembled for the NLWRA Extension of Monthly Mean Flow project.
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>Australian Capital Territory</td>
</tr>
<tr>
<td>AIC</td>
<td>Akaike Information Criterion</td>
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<tr>
<td>ALS</td>
<td>Airborne Laser Scanning</td>
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<tr>
<td>AML</td>
<td>Arc/Info Macro Language</td>
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<tr>
<td>ANRDL</td>
<td>Australian Natural Resources Data Library</td>
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<tr>
<td>ASRIS</td>
<td>Australian Soil Resources Information System</td>
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<tr>
<td>AusRivAS</td>
<td>Australian River Assessment Scheme</td>
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<tr>
<td>AWRC</td>
<td>Australian Water Resources Council</td>
</tr>
<tr>
<td>BIC</td>
<td>Bayesian Information Criterion</td>
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<tr>
<td>CAPAD</td>
<td>Collaborative Australian Protected Areas Database</td>
</tr>
<tr>
<td>CAR</td>
<td>Comprehensive, adequate and representative</td>
</tr>
<tr>
<td>CFEV</td>
<td>Conservation of Freshwater Ecosystem Values</td>
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<tr>
<td>CRES</td>
<td>Centre for Resource and Environmental Studies</td>
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<tr>
<td>CS</td>
<td>Classification Strength</td>
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<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
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<tr>
<td>DEM</td>
<td>Digital Elevation Model</td>
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<tr>
<td>ECS</td>
<td>Evaluated Corridor Section</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>IBRA</td>
<td>Interim Biogeographical Regionalisation of Australia</td>
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<tr>
<td>IUCN</td>
<td>International Union for the Conservation of Nature and Natural Resources</td>
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<tr>
<td>mrRTF</td>
<td>multi-resolution Ridge Top Flatness Index</td>
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<tr>
<td>mrVBF</td>
<td>multi-resolution Valley Bottom Flatness Index</td>
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<tr>
<td>NHRP</td>
<td>National River Health Program</td>
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<td>NLWRA</td>
<td>National Land and Water Resources Audit</td>
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<td>NRM</td>
<td>Natural Resource Management</td>
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<td>NRS</td>
<td>National Reserve System</td>
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<td>New South Wales</td>
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<td>NVIS</td>
<td>National Vegetation Information System</td>
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<td>RDI</td>
<td>River Disturbance Index</td>
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