Wetland classification and delineation – lessons from international projects

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Global reviews of wetland inventory, classification and delineation

Initiatives/meetings over two decades have identified lessons and recommendations under several themes:

- **collect long-term data on ecological character**
- **standardise classifications & guidelines for delineation**
- **provide training in data collection, delineation/mapping**
- **review gaps and co-ordinate data collection**
- **develop and use expert and community networks**
- **develop means to audit or review existing effort**

Ramsar global review of wetland inventory

Outcomes

- **Few countries have comprehensive national inventory; many (most?) lack basic information on wetland types and area**
- **Purpose of many inventories poorly stated – classifications and delineation methods not clear or non-systematic**
- **Include basic information on location/extent of wetlands and ecological features before classifying or delineating**
- **Use core data sets along with standardized methods for classification and delineation … and make them accessible**

Inventory, assessment & monitoring

Inventory

Collect information to describe, classify and delineate the wetland – provides a basis for assessment and monitoring

Assessment

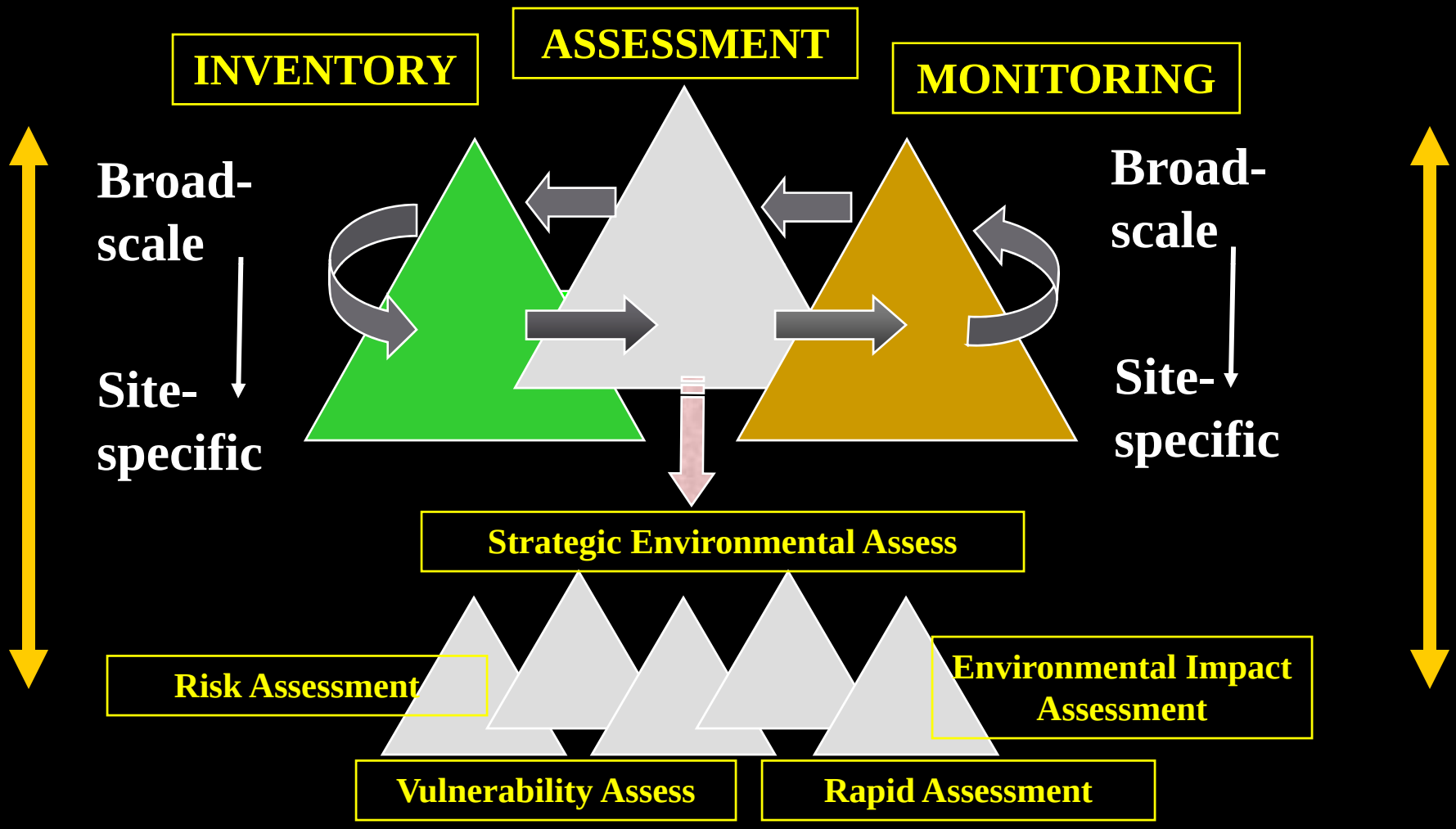
Identify the value, status of and threats to the wetland - provide a basis for monitoring

Monitoring

Collect information for management based on hypotheses derived from assessment

Integrated multi-scalar wetland analyses

Consultation & Communication



Modelling & Research

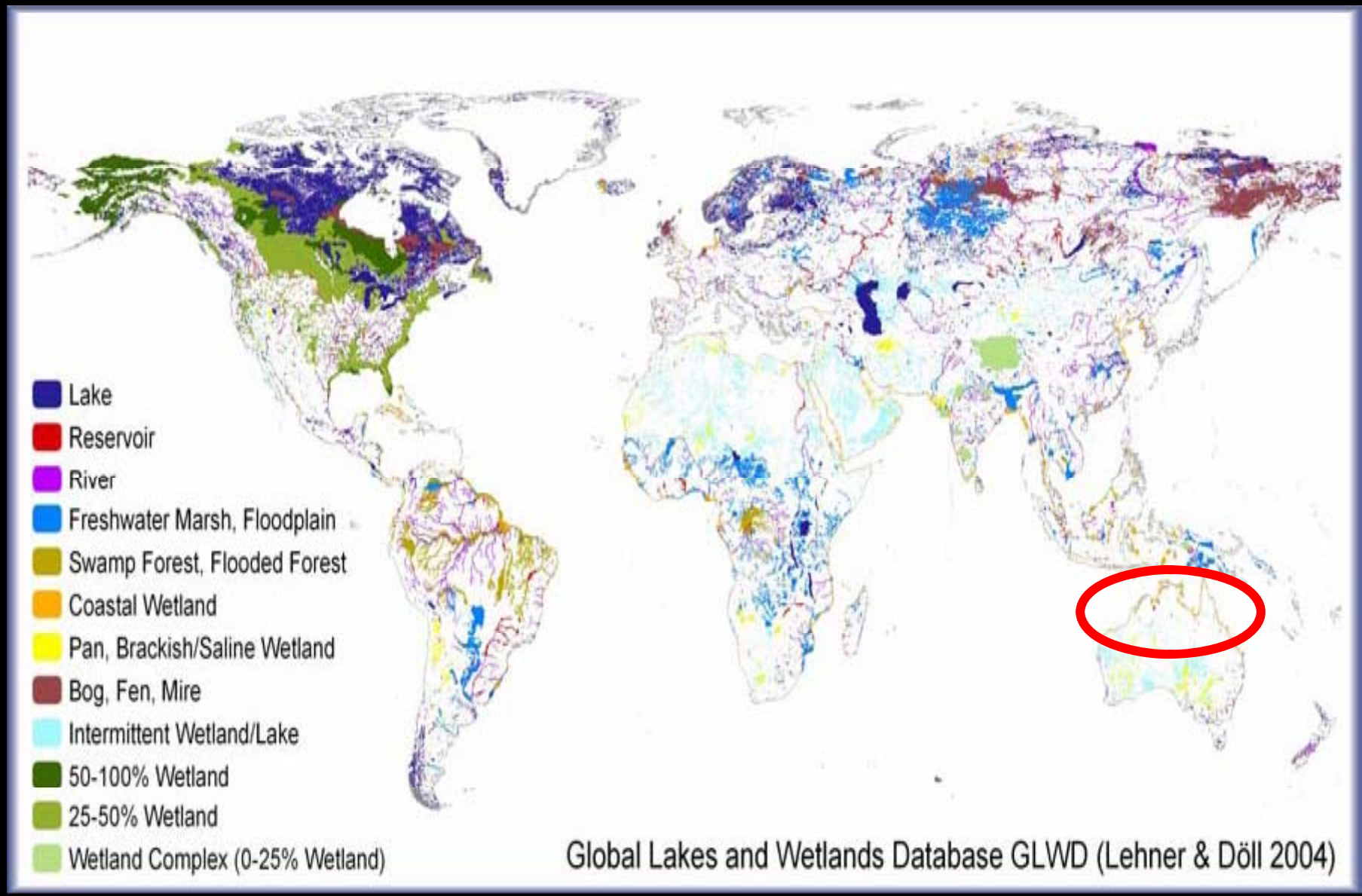
Wetland definition, classification and delineation

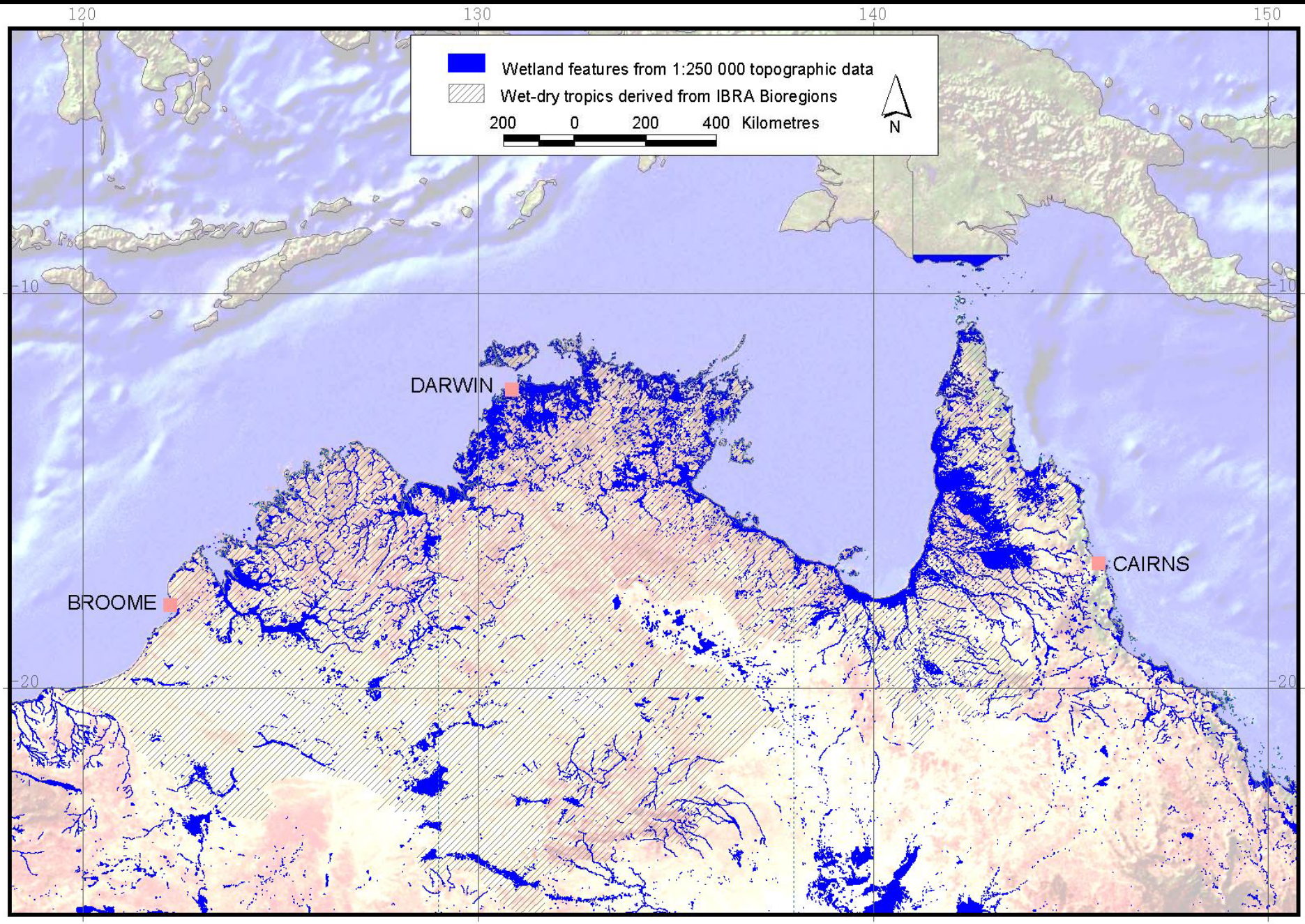
• **Definition** – general set of criteria for identifying wetlands from non-wetland areas; many definitions covering inland, coastal and marine ecosystems, including swamps, marshes, lakes/ponds, fens/bogs, rivers, karsts, shell/coral reefs …..

• **Classification** – set of criteria for differentiating between wetland types; often hierarchical based on water regime, landform, substrate, vegetation, water quality ….

• **Delineation** – establishing the boundary of wetlands from non-wetland areas, or between wetland habitats within a wetland

Scale is important – global, regional, local




120
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Wetland features from 1:250 000 topographic data
Wet-dry tropics derived from IBRA Bioregions
200 0 200 400 Kilometres
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Classification

1. What is the purpose – describe the location, the vegetation, or the succession, or hydrological functioning, or land uses including conservation ……..what criteria are needed?

2. What is the geographic scope and scale - for a small area within a single country, or region, or international?

3. What information is available to classify individual wetlands, or elements within a single wetland – landform, water regime, vegetation, water quality?

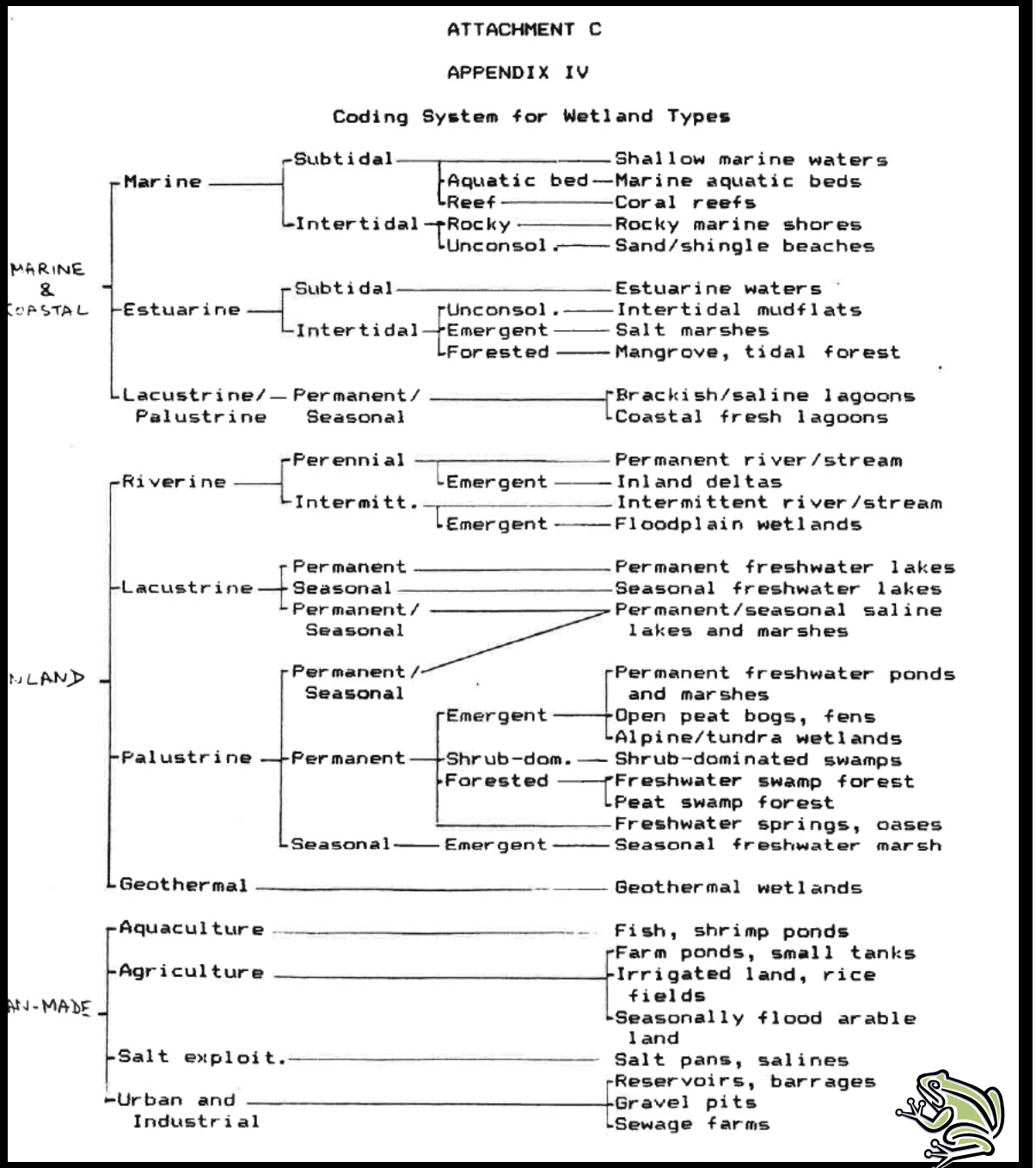
4. Is the application desk-based using limited information, or field-based with verification and empirical data collection?

5. How will the classification be used and by whom?

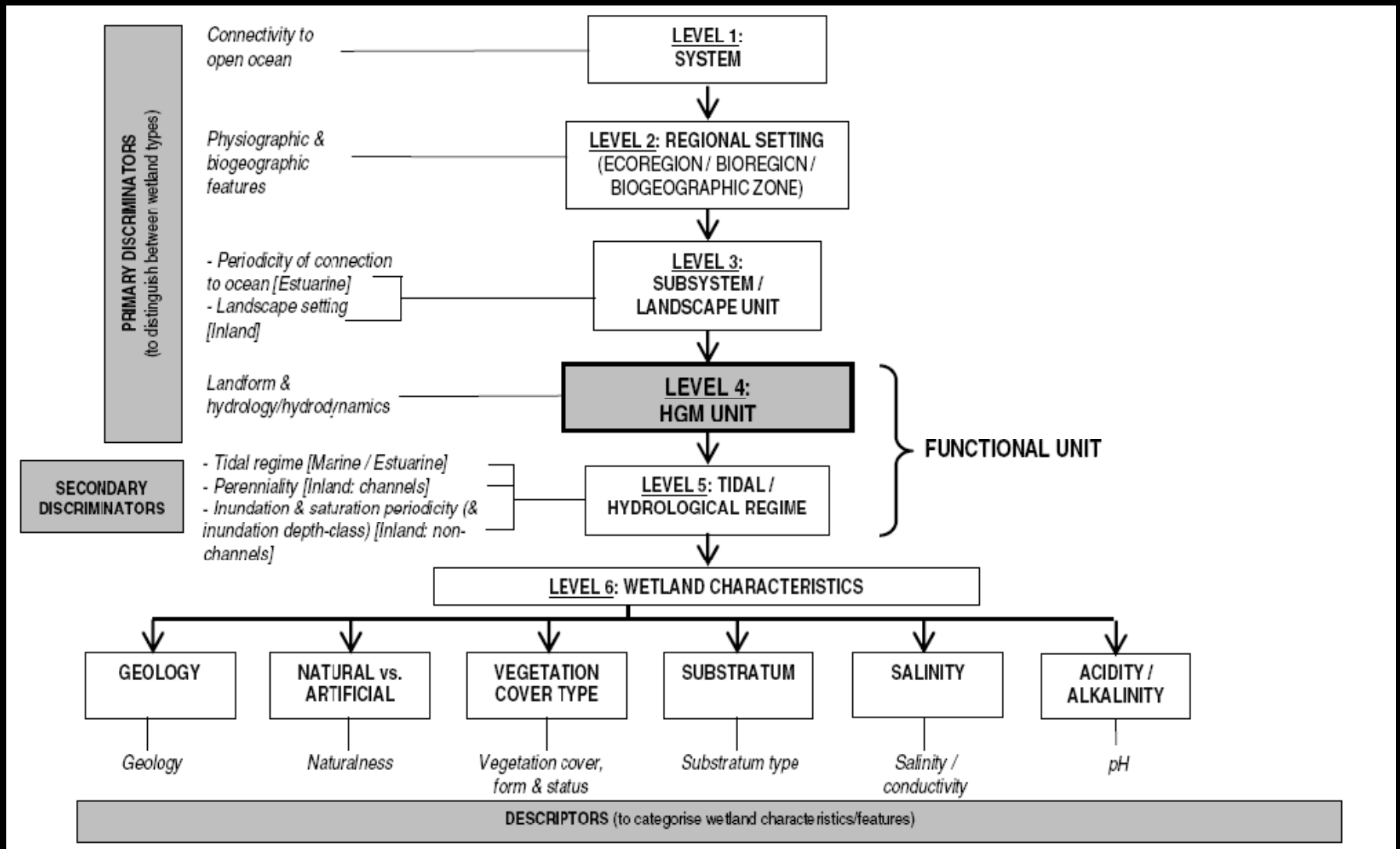
Hierarchical wetland typology – Ramsar Convention – Scott 1989.

Original sketch of the hierarchical system – simple purpose of categorising Ramsar sites.

Modified but not greatly changed since – it is in use for approx 1900 sites – why change?



South African National Wetland Classification (SANBI 2009)

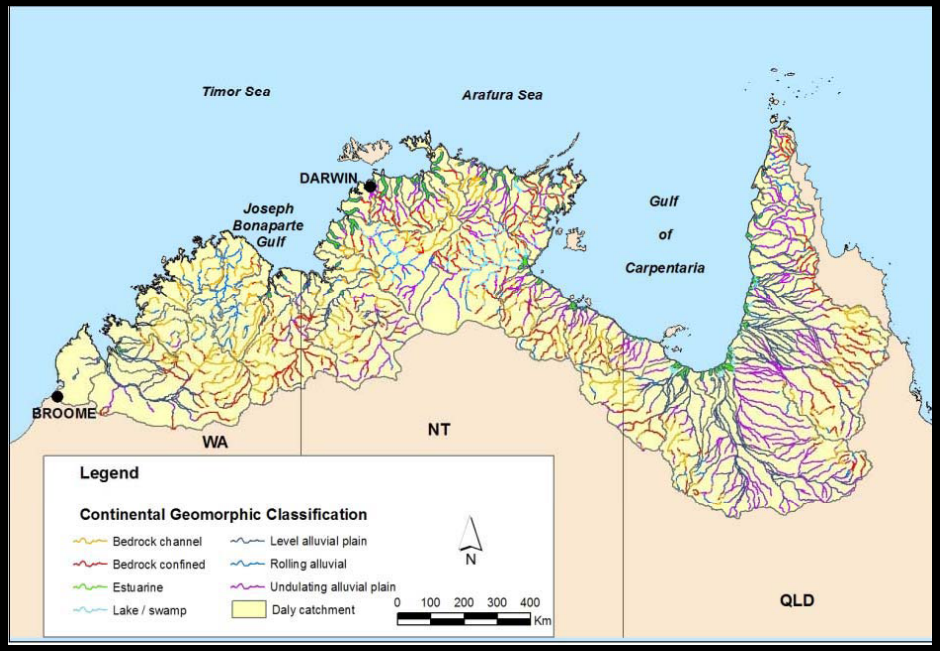


Primary discriminators up to Level 4 to classify hydro-geomorphic units, secondary discriminators at Level 5 to classify the tidal/hydrological regime, and descriptors at Level 6 to categorise the characteristics of wetlands classified up to Level 5.

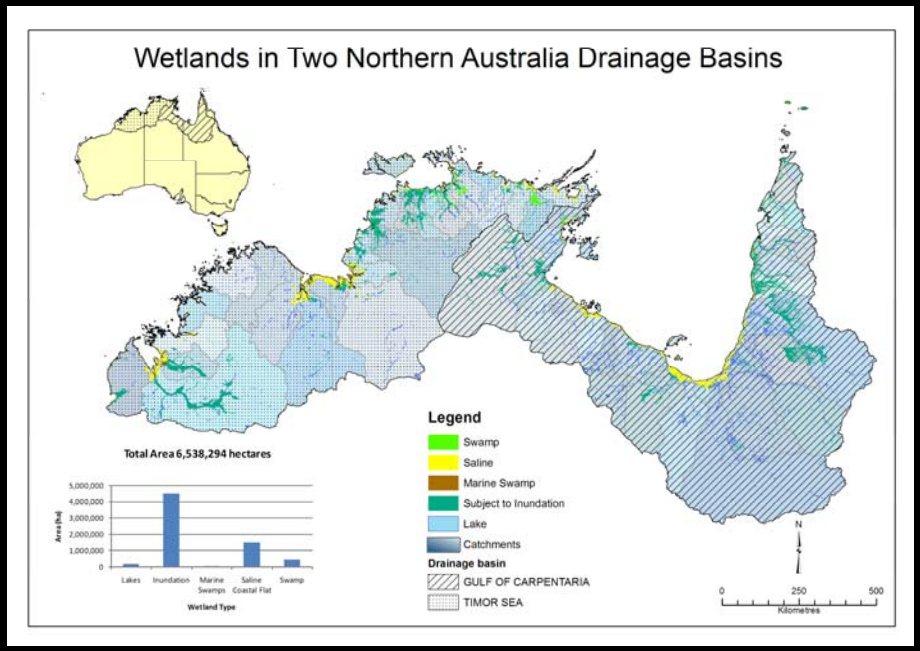
Classification (and mapping) of habitat types

- A way of categorising wetlands: supports inventory and natural resources management. (Mapping improved by use of GIS and Earth Observation tools.)

- Classification for different purposes can be done after core data collected. Data covers landform, water regime, vegetation cover …



River types (Saynor et al 2008)



Wetland types (Lukacs & Finlayson 2008)

Caution:

- **Using a wetland types derived for one purpose for another purpose can be dangerous.**

- **Classification means different things to different people - it is essential to know what the classification is for before using an off the shelf system.**

- **Need for consistency within classification and when comparing between areas or different studies – consistent scales and criteria for classification.**

Key rule is to define your purpose, scale and criteria and apply them consistently. Whenever possible base on core data from inventory – efficiency and relates classification to the purpose of inventory.

Core data – typically includes a combination of landform, water regime, water quality and vegetation cover – collected during inventory and used to classify wetlands

(a) Essential core data elements

- Area and boundary[A] (size and variation, range and average values)
- Location[A] (coordinates, map centroid, elevation)
- Geomorphic setting[A] (where it occurs within the landscape, linkage with other aquatic habitats, biogeographical region)
- General description (shape, cross section and plan view)
- Soil (structure and colour)
- Water regime (periodicity, extent of flooding and depth)
- Water chemistry (salinity, pH, colour, transparency)
- Biota (vegetation zones and structure, animal populations and distribution, and special features including characteristic or rare/endangered species)

Ramsar core data for inventory – can be used for classification - data also collected on management, land use, ecosystem services.

Core data – formats and standard terms or categories for classification – can be combined in any combination as needed

TABLE 14: Terms for defining the areal extent of a wetland complex (adapted from Semeniuk 1995).

Classification	Frame of reference for all categories except channels	Frame of reference for channels (width to length relationship)
Very large	> 10 x 10km	> several km wide; hundreds of km long
Large	1000 x 1000m to 10 x 10km	Several hundred m wide; several to tens of km long
Medium	500 x 500m to 1000 x 1000m	Hundreds of m wide; thousands of m long
Small	100 x 100m to 500 x 500m	Tens of m wide; hundreds of m long
Very small	< 100 x 100m	Several m wide; tens of m long

TABLE 18: Salinity classification.

Classification	Salinity (g L^{-1})
Fresh	< 0.5
Brackish	0.5–18.0
Semi -saline	18.0–30.0
Saline	30.0–40.0
Hypersaline	40–100
Ultrasaline	> 100

TABLE 21: General relationship of wetland productivity to average concentrations of total phosphorus (from Wetzel 2001).

Category	Total P (µgm/l)
Ultra-oligotrophic	< 5
Oligo-trophic	5–10
Meso-eutrophic	10–30
Eutrophic	30–100
Hyper-eutrophic	> 100

Finlayson et al (2002)

Core data - further examples

TABLE 12: Categories of landforms that are host to wetlands (adapted from S
Semeniuk 1995 and from Kotze et al 1994).

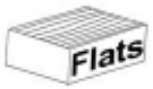
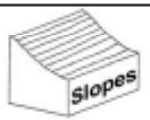
Landform	Definition	
Basins	Basins are depressed basin shaped areas in the landscape with no external drainage. They may be shallow or deep and may have flat or concave bottoms. They usually have clearly defined margins.	
Channels	Channels refer to any incised water course. They may be shallow or deep but always have clearly defined margins.	
Flats	Flats have a slope of less than 1%. Little or no relief and diffuse margins. Flats can be incised by a channel thereby giving rise to the term 'channeled flats'.	
Slopes	Slopes are areas with a gradient of greater than 1% which may be concave or convex.	
Hills / highlands	Hills / highlands are generally convex areas on the top of mountains, hills or similarly raised areas.	

TABLE 16: Categories of non-tidal water regimes for wetland habitats (adapted from Semeniuk & Semeniuk 1995)*.

Water regime	Definition
Permanently inundated	Areas where land surface is permanently covered with free-standing water (except in years of extreme drought).
Seasonally inundated	Areas where land surface is semi-permanently flooded. When surface water is absent, water table is at or near surface.
Intermittently inundated	Areas where the land surface is temporarily flooded. Surface water is present for a brief period during the year but water table is otherwise well below the soil surface.
Seasonally waterlogged	Areas where land surface is saturated for extended periods but surface water is seldom present.

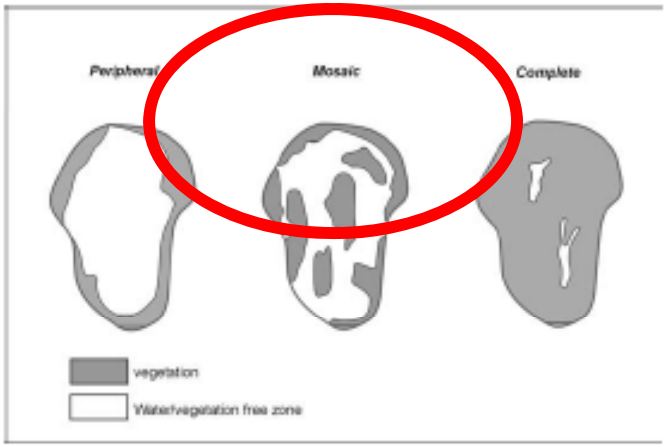


FIGURE 3: Categories of vegetation cover (after Semeniuk et al 1990).

Finlayson et al (2002)

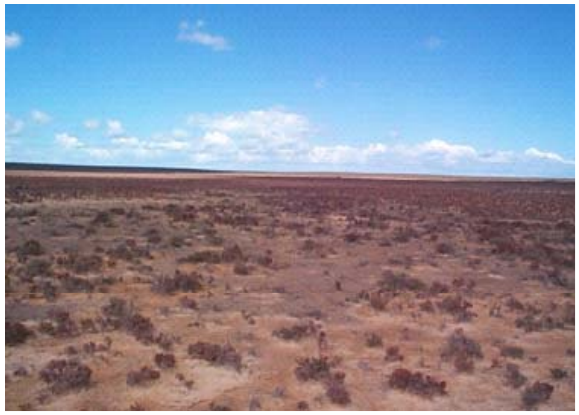
Delineation

• Can only occur when there is a clear definition of what a wetland is and the reason for the delineation. Definition needs to be broken down so that each component of the definition can be used in a delineation process based on the attributes of the definition.

• Lots of caveats on delineation - the scale at which it should occur - important to determine the minimum scale at which a wetland should be delineated and beyond which it will cease to be seen as a wetland.

• Delineating wetland complexes and landscapes containing wetlands need different rules than when a wetland is clearly definable.

Delineation



Steps to identify and delineate wetlands

- Framework with multiple criteria provided to ensure information is collected in an efficient and effective manner. The more criteria covered when delineating a wetland the stronger the evidence.

- Not all steps will be needed to make a wetland determination and boundary delineation.

- Where good existing information is available or where an obvious wetland boundary occurs in the field and can
- be readily identified on imagery, it may be possible to make a determination during the first three steps.

Steps for wetland survey and delineation

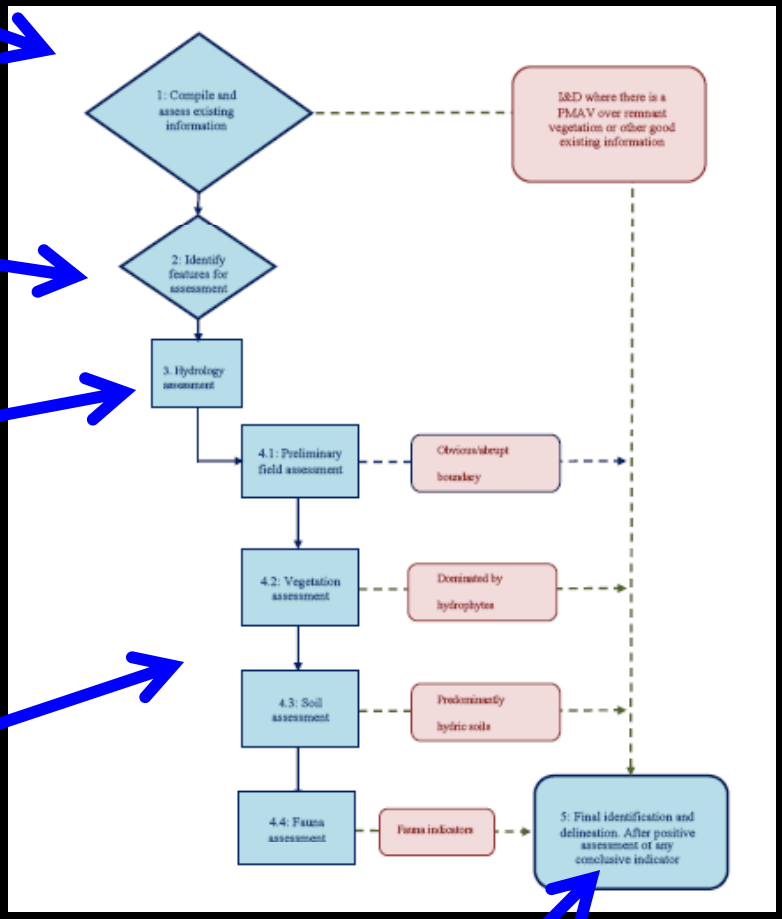
Step 1 – Compile and assess existing information

Step 2 – Identify features for assessment

Step 3 – Hydrological assessment

Step 4 – Field assessment

- Step 4.1 – Preliminary field inspection
- Step 4.2 – Vegetation assessment
- Step 4 .3 – Soil assessment
- Step 4.4 – Fauna assessment



Step 5 – Final identification and delineation

Department of Environment and Resource Management (2010)

Delineation – use of Earth Observation to determine the boundary of flood extent under closed forest canopies

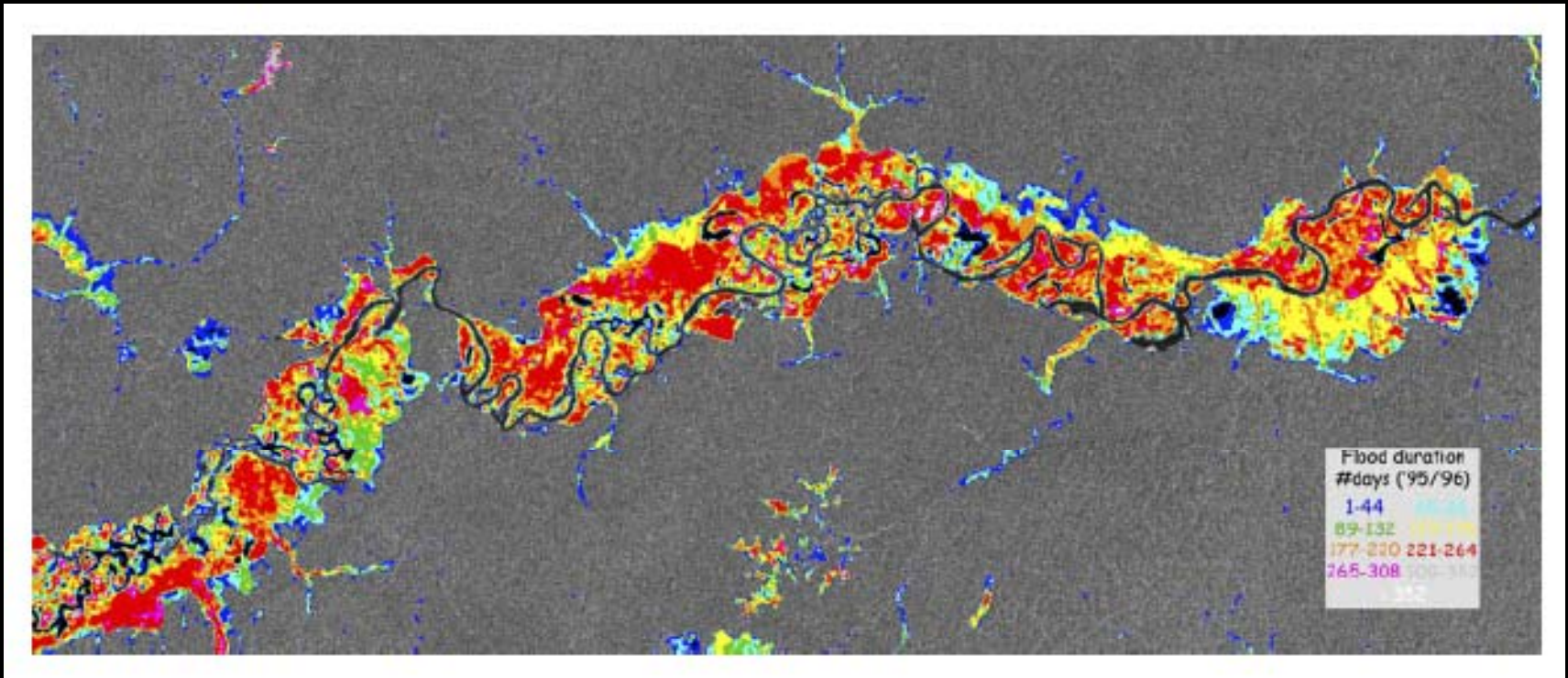
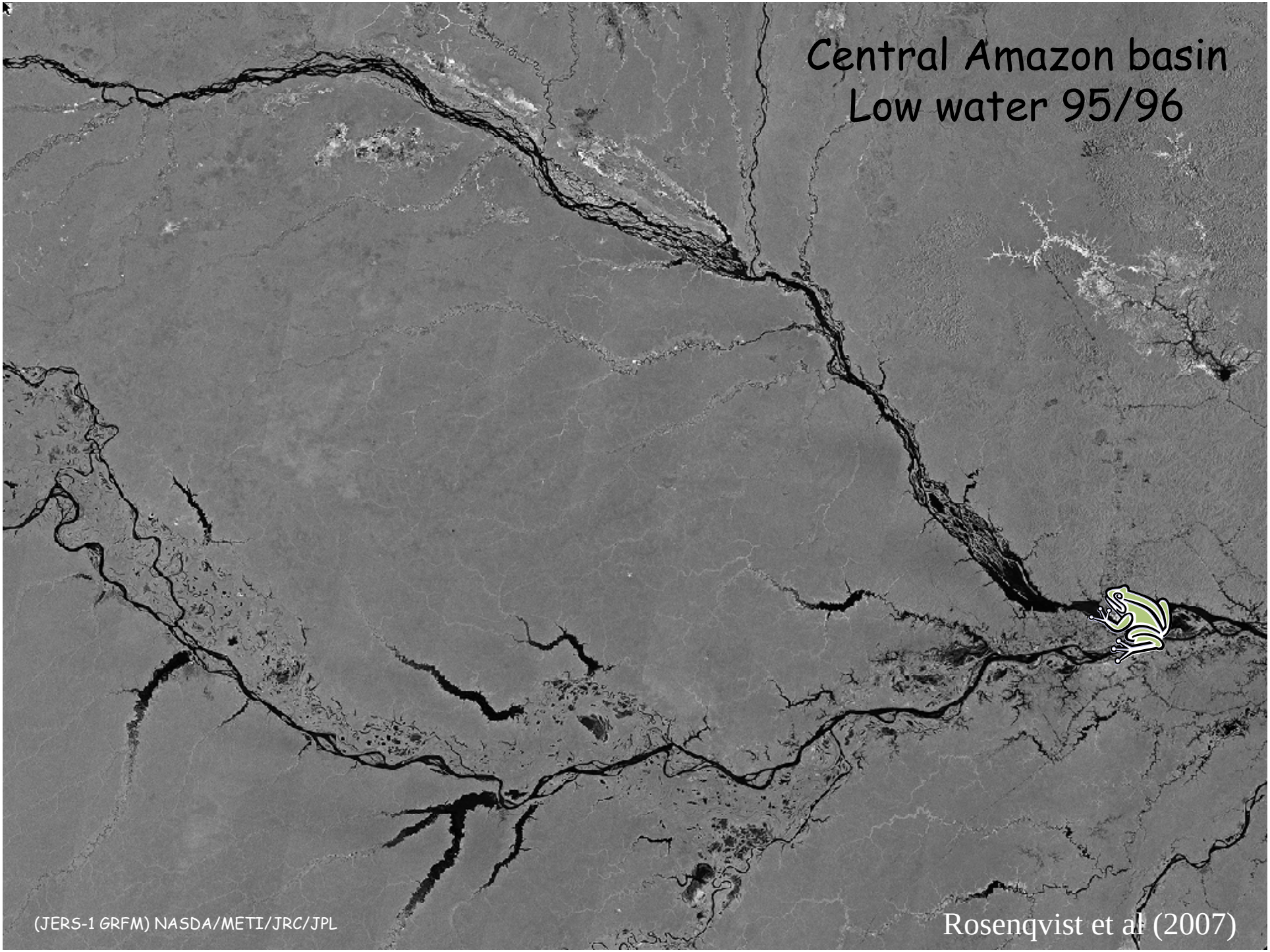
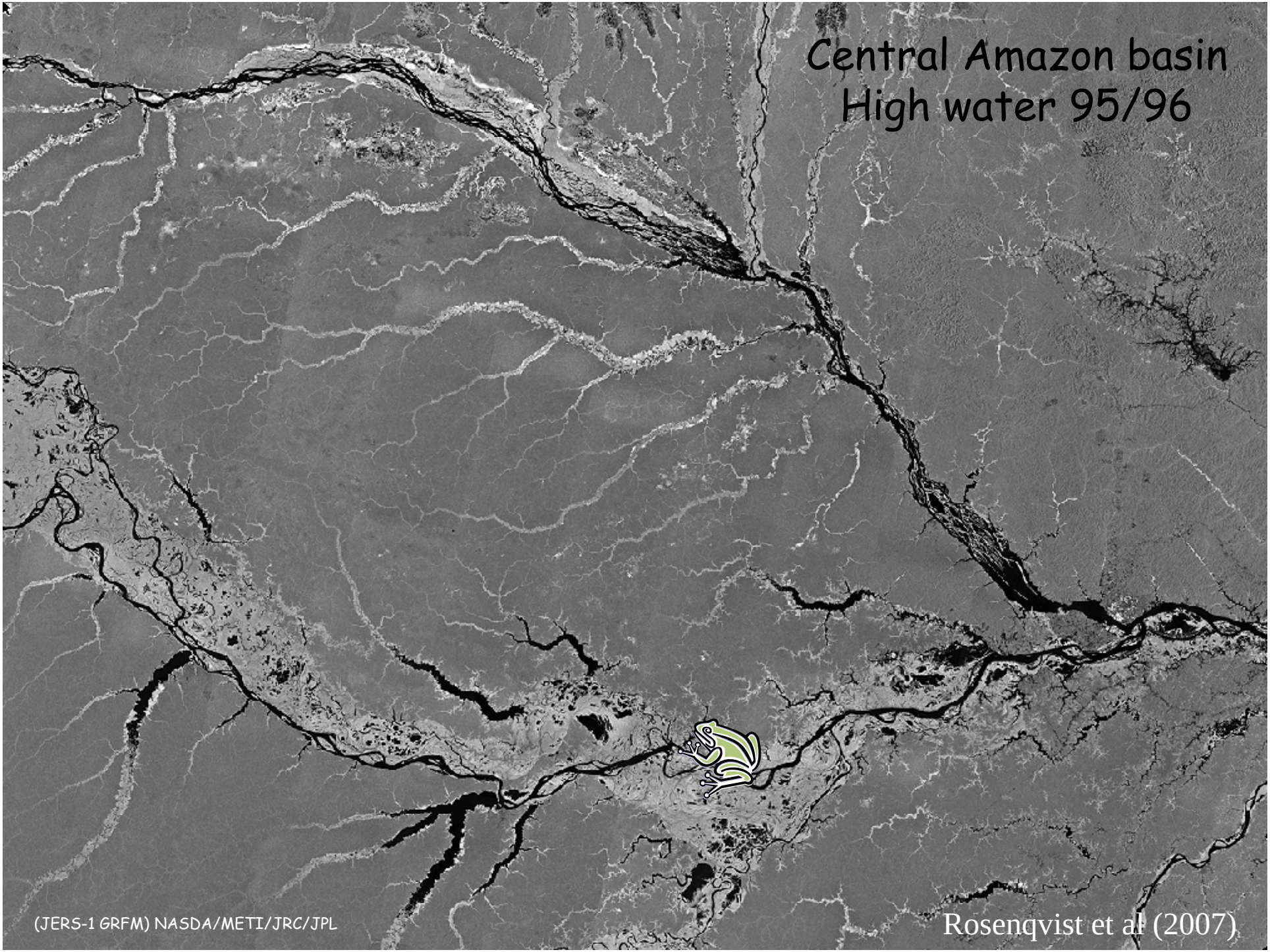


Figure 4. Mapping inundation below a closed forest canopy. The flood duration map, which was derived from a time series of nine JERS-1 L-band SAR images acquired every 44 days during one full seasonal flooding cycle from October 1995 to October 1996, shows the spatial and temporal distribution of seasonal inundation in a tributary of the Rio Negro, Brazil. The colours overlaid on the SAR image indicate the duration in days during which a particular point was inundated. Grey areas are non-flooded forest, black areas show the open water river channel. © JAXA/METI.

Rosenqvist et al (2007)


Central Amazon basin
Low water 95/96
(JERS-1 GRFM) NASDA/METI/JRC/JPL
Rosenqvist et al (2007)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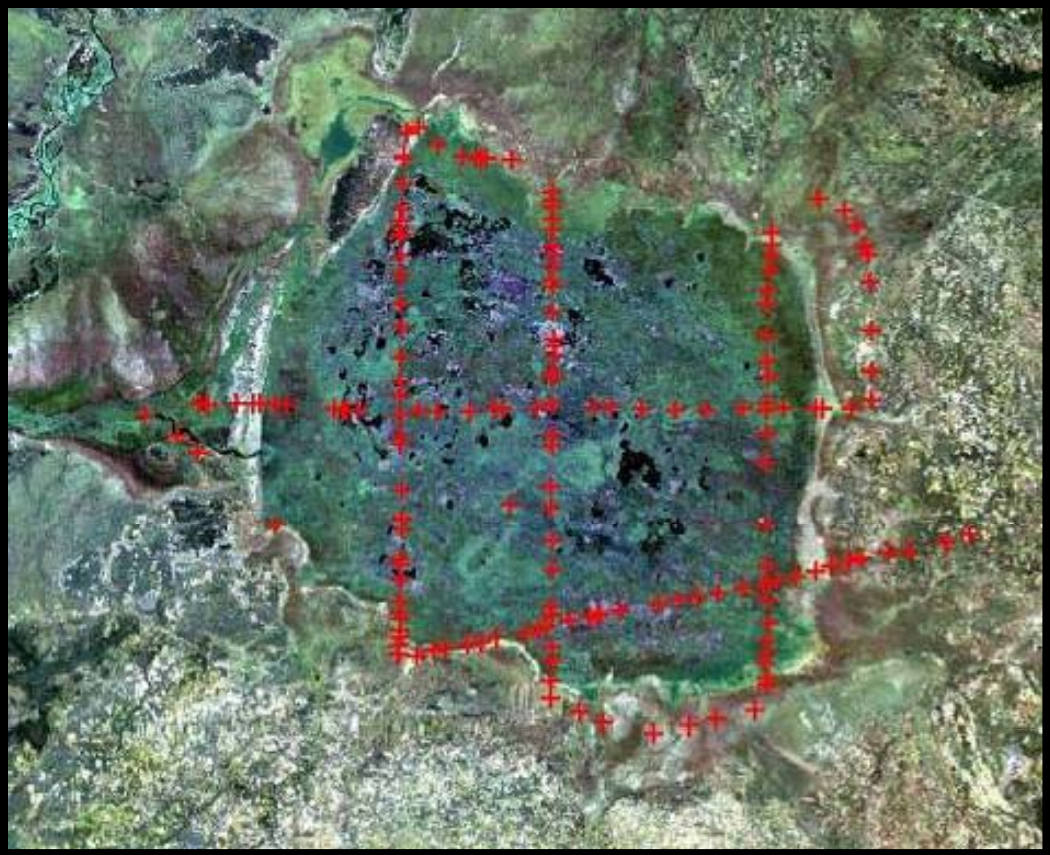
(JERS-1 GRFM) NASDA/METI/JRC/JPL
Rosenqvist et al (2007)

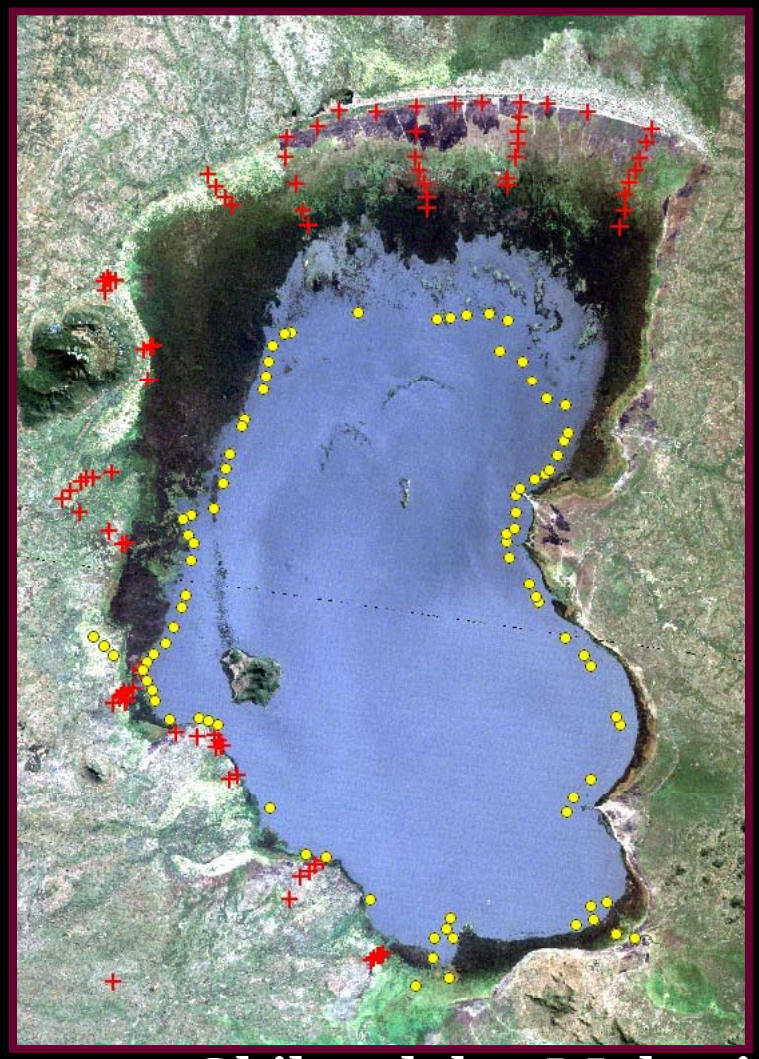
Delineation (and mapping) increasingly done using Earth Observation data based on land cover / vegetation – key issue of representative ground truthing

Lukanga Swamp, Zambia

Landsat TM real colour composite (3,2,1) May 2006



Rebelo et al (2009)



Chilwa lake, Malawi

Landsat TM real colour composite (3,2,1) May 2006

Wetland classification and delineation

What is the purpose/s of the wetland classification – how will it be used? What criteria should be included? Is it hierarchical? What core data is needed, and available? How will it be documented? Does it correspond with other classifications?

What are the criteria for delineation? What scale/s will be used? Does it account for variation in flooding? How will the lines be identified and drawn? How will the data be managed, and made accessible?

What wetland types are not included in the classification and delineation?

Thank-you