Landscape evaluation of restored ecosystems.

Social and cultural evaluation of restoration projects

David Lamb
University of Queensland
Australia

Some key issues

- Restoration is difficult (don't always have necessary techniques)
- Difficult to predict successional outcomes
- Restoration is expensive
- Restoration may not generate any direct benefits for several years
- Any benefits may go to community rather than site owner
- Hence – restoration may be unattractive to landowners

Questions to be addressed

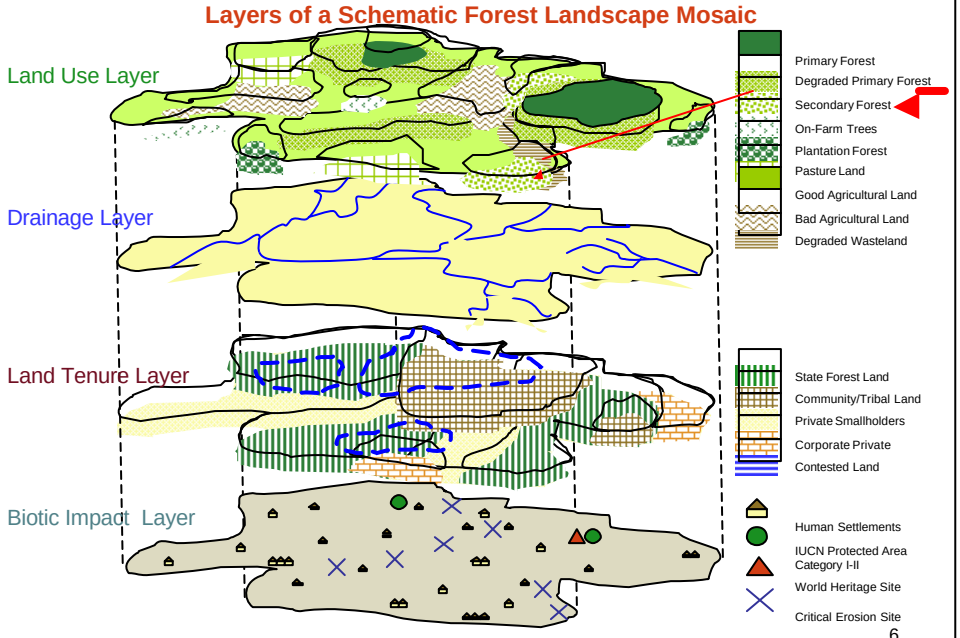
- How does the landscape mosaic influence how we might carry out restoration?
- How can socio-economic circumstances affect restoration options?
- What lessons can we learn from past attempts at restoration?
- What are ways of evaluating social and cultural consequences of restoration

Use Case Studies to illustrate main points

The Landscape Mosaic

The Landscape Mosaic

- The landscape is a mosaic of land uses and ecosystems
- Some parts “degraded” and others productive
- Also contains a variety of stakeholders
- Many interactions between
  - Biological and physical components
  - Social and ecological components
- These interactions at a variety of scales



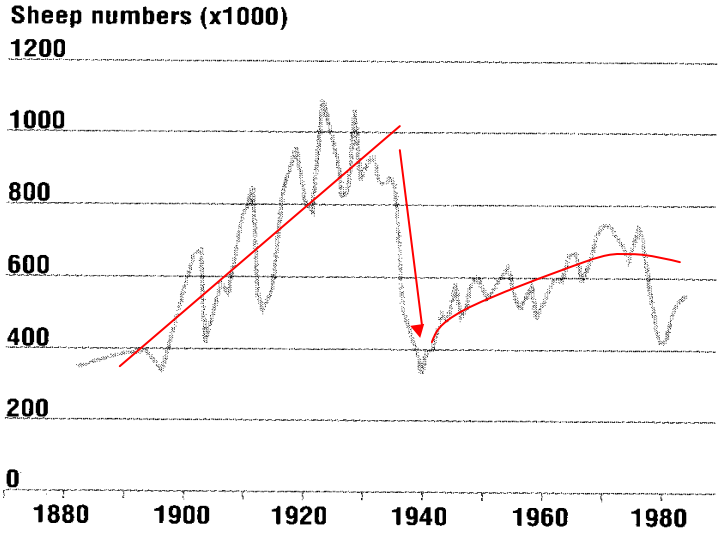
The Landscape Mosaic continued

6. Hard to predict outcomes of these inter-actions
7. Need for monitoring and adaptive management
8. Emergent properties
   - Vegetation and erosion
   - Changes in fire regime
   - Dispersal of biota
9. Restoration adds a new level of complexity
   - Has ecological consequences
   - Has social and economic consequences
10. Landscape mosaic is dynamic and changing over time

The Landscape Mosaic continued

11. Many landscape have been used by humans for a long time
12. Some species go extinct
13. Other species become naturalised
14. Legacy of past event may influence current options
    - Droughts
    - Fire

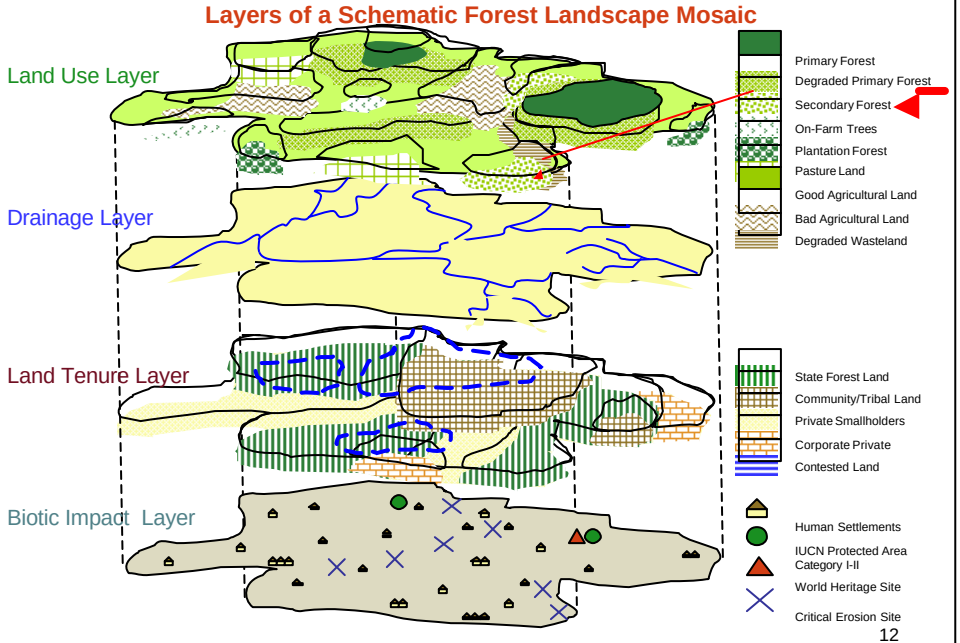
Figure 6.9 Sheep numbers in the rangelands of the West Gascoyne region of WA



Annual fire for 40+ years

No fire for 40+ years

The ecological components of the Landscape



Ecological components of the Landscape Mosaic (1)

1. Undisturbed natural vegetation	Extent of canopy cover, Proportion intact (30% rule), degree of fragmention or connectivity Ability to supply goods and services
2. Area of regrowth or shrubland vegetation	Supply of goods and services? Ability to recover unaided? Suitable for other land uses?
3. Diversity of ecosystems present	Habitat distribution patterns Natural, agricultural, forest plantation?
4. Area of “good” agricultural land	For food production For livelihood or commercial purposes Subsidized – financially? Ecologically?
5. Area of “poor” agricultural land	Available for restoration? Low opportunity cost?

The Ecological components of the Landscape Mosaic (2)

6. Areas of biological significance	High biodiversity Endemic species Flagship species
7. Environmental priority areas	Sources of erosion, salinity or pollution? Sites subject to threatening processes
8. Endangered, vulnerable or rare species	Locations and spatial extent
9. Exotics (plants or animals)	Recent or naturalised Spatial distribution
10. Fire regime(s)	Frequency and intensity Historical or new

The Ecological components of the Landscape Mosaic (3)

11. Topography and drainage patterns	Erosion and soil movement? Affects habitat location (e.g. riverine areas)
12. Geology and soils	Affects soil fertility and thus species-site relations Degree of soil degradation (topsoil loss, compaction, salinity etc.)
13. Areas difficult to restore	Steep Heavily polluted Loss of fertility
14. Degree of isolation	accessibility
15. Trends over time in all of the above	Is the landscape becoming more or less degraded?

Sources of information

- Land use maps
- Remote sensing data
- Nature conservation agencies
- Local residents
- Field visits

Case Studies

- Background
- What was done
- Outcomes
- Landscape evaluation
- Restoration possible because….
- Key points arising

Case Study 1: Restoration may occur if further disturbances are prevented

Case Study 1: Restoration of Hinewai Forest, New Zealand

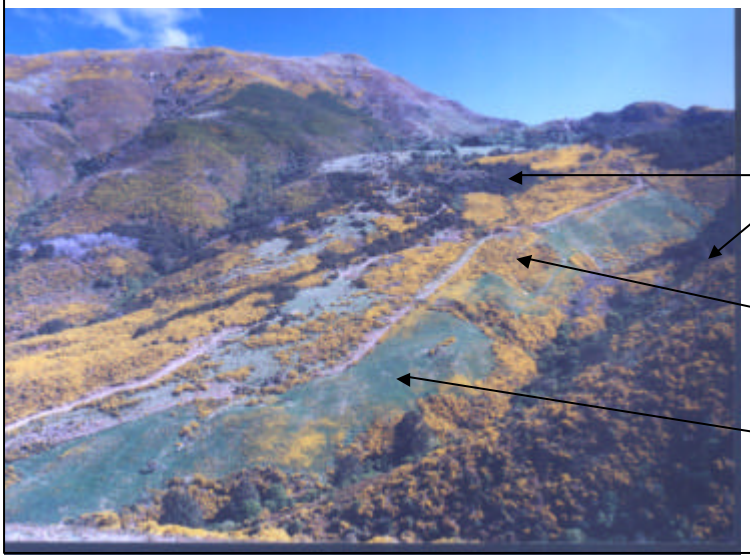
BACKGROUND

- Cool temperate forest landscapes
- Area of 1000+ ha degraded by sheep grazing
- About 4 percent natural forest remaining
- Exotic species
  - weeds (gorse and broom)
  - animals (possums, rabbits, goats, cats, etc.)
- Marginal for farming
- Land purchased by a Trust in 1987

What was done

- Objective: to restore natural temperate hardwood forests
- This done by “minimum interference management”
  - Removing sheep
  - Removing other exotic wildlife (possums, cats etc)
  - Strict fire control
  - Ignore weeds (except for buffer strip around area to ensure support of neighbours)

Hinewai Reserve in 1988 at the commencement of restoration



21

Hinewai Reserve in 2000, twelve years after grazers excluded.

Note:

Forest
-Increase

Gorse
-Increase

Pasture
- disappeared

22

Outcomes

- Spread of gorse in absence of clearing
- BUT - gorse facilitates tree seedling growth
- Tree seedlings grow up and shade out gorse
- Biodiversity increases
- Increased interest from neighbouring landowners

Landscape Evaluation

- Prognosis: successional trajectory established
- Likely that natural forest ecosystem will completely cover the area (50 years?)
- Full biodiversity recovery?

Why did “recovery” occur?

Restoration possible because:

- Group owned all the land
- Remnant forest nearby
- Sheep removed
- Seed able to disperse across landscape
- Seedlings able to regenerate and grow beneath “weeds”
- Weeds will be eradicated by shade
- Soil fertility not limiting
- Able to eradicate exotic pest species
- Able to exclude fire
- Access good
- Poor land with low opportunity cost
- Treatment costs “low”
- Neighbours were tolerant

Key points arising from Case Study

- Site was not too degraded
- Restoration was “cheap” (?)
- Sufficient biodiversity was still present to enable system to recover

BUT what if:

gorse was not a facilitator but an inhibitor?

it was not possible to get rid of pest herbivores?

not all species recolonised?

The human component of landscape restoration

The human component (1)

1. Population	Density Trends over time?
2. Land tenure patterns	Farm area per household? Legal tenure? Areas of contested ownership?
3. Farmer incomes	Wealthy or poor? On and off-farm income?
4. Land use patterns	Stable or changing? Dependent on tradition? Depend on incentives or subsidies?
5. Conservation attitudes or knowledge	Interest in “restoration”? Long-term residents or newcomers?

The human component (2)

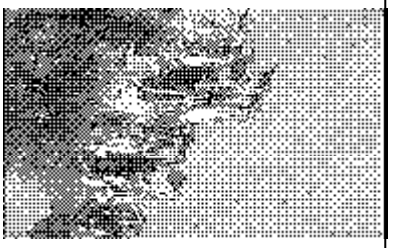
6. Other stakeholders	Resident or non-resident? Individuals or institutions? State agencies? ~~Politically powerful or not?~~
7. Neighbours	Allow stock to invade? Allow fires to burn? Allow pests or weeds? ~~Steal goods?~~
8. Restoration seen as a benefit	Can earn additional income from goods created? ~~Payment for ecological services?~~
9. Restoration seen as a cost	Ecological benefits go to others? Benefits delayed too long? ~~Restoration is too risky?~~

Case Study 2: restoration may occur if former cultural practices are re-instated

Case Study 2: Shinyanga, Tanzania

Background

- Semi-arid lands
- Used for agro-pastoralism
- South of Lake Victoria,
- 1.77 million people; high population densities;
- Used to use exclosures (“nigilti”) to conserve fodder for dry season and woodlands for fuel and other NTFPs



Shinyanga, Tanzania continued

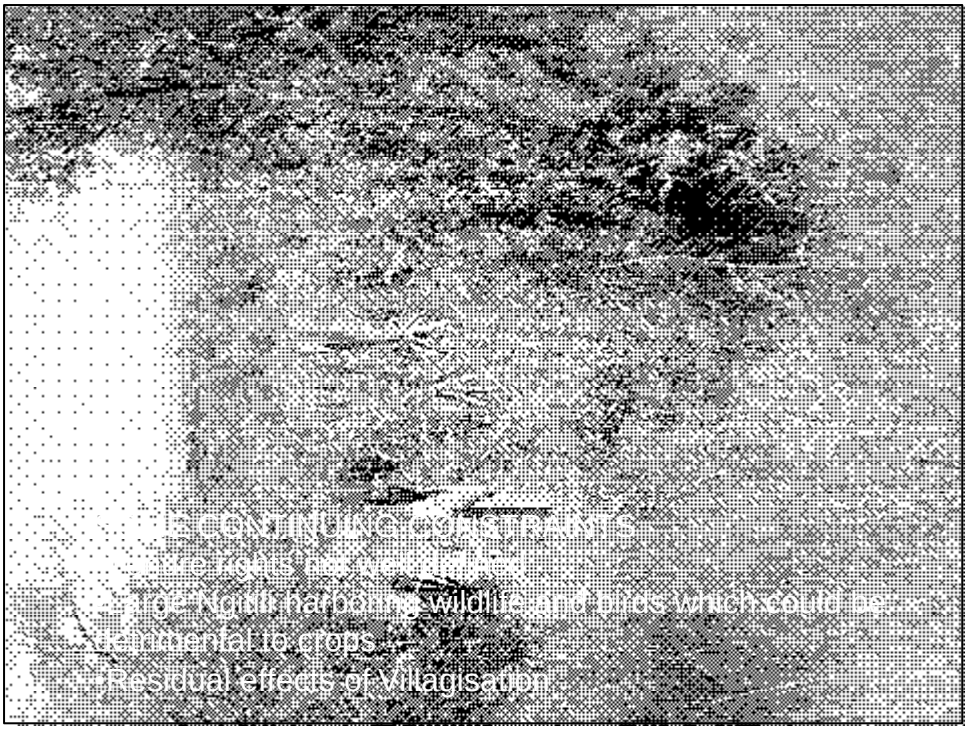
- Massive deforestation between 1920-40 to eradicate tsetse fly;
- Cash crop production causing further land conversion;
- Increased livestock numbers exacerbate problem;
- “Villagisation” Policy (1975) resulted in centralisation of people into villages and the destruction of many traditional land use practices
- Widespread degradation – the “Desert of Tanzania”

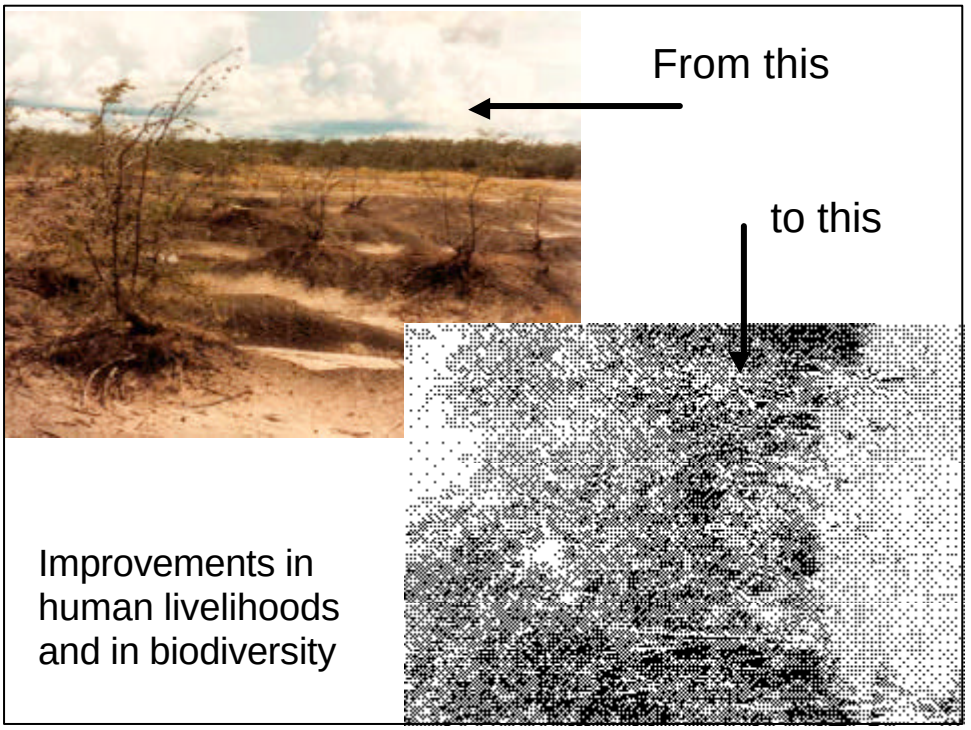
Restoration after 1980's

What was done

- Government agrees to re-instate old land use practices
- Abandons "villagisation"
- Encourages "nigiliti" enclosures (5-100 ha)
- Encourages traditional rules of land use and access to enclosures
- Since 1986 create a total of 18, 323 Ngitili
- Cover 87,742 Ha in Shinyanga Region

Cattle removed for >5 years to allow restoration





Landscape Evaluation

- Very large scale restoration
- Changed landscape mosaic – more forest patches
- Many native species recover
- Unclear which species will NOT recover

Restoration possible because

- Sites not too degraded – could recover once grazing pressure regulated
- Change in government policy – land tenure granted
- Landowners had incentives to restore (sites had been low productivity)
- Were able to re-instate traditional management regimes
- Traditional law supported by state laws
- Provide multiple benefits (pasture and NTFPs)
- Process not costly

Key points arising from Case Study

- Not so degraded that natural recovery impossible
- Massive change occurring because of a policy change

Question: what biodiversity components did NOT recover???

Case Study 3: Land owners may be trapped by economic circumstances and not be able to apply appropriate restoration techniques

Case Study 3: Changed fire regime, Australia

Background

- Aboriginal arrive in Australia ca 50,000 years ago
- Used fire for hunting etc.
- Fire regimes tended to be
  - Frequent
  - Low intensity
  - "cool" season
- Consequence was increased grass cover

Changed fire regime, Australia

What happened

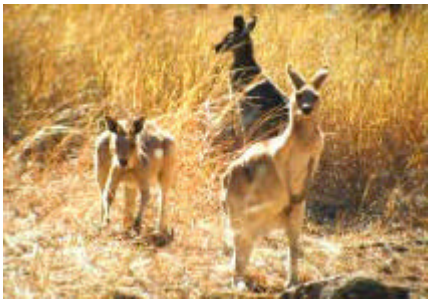
- Pastoralists arrive
  - Exclude fire
  - Bring new herbivores (cattle, sheep)
- Grazing causes a reduction in grass (= fuel)
- Allows increased density of fire-sensitive woody plants
- Shading reduces area with grass
- This reduced fire hazard
- Hence favours woody plants
- These exclude more grass
- This reduces fire hazard etc……..

Solutions?

- Light fires to exclude woody “weeds”?
  - But not enough grass (fuel) in normal year
  - Only in good year (1:20 years?)
  - This might be the best year in a farmers working life?

Solution?

- Suppose they burn – will it work?
  - Only if a large area burned (because…)
  - Hence need alternative feed for livestock
  - Also need collaboration with neighbours?
- Doomed ecologically if they don't burn – may be doomed economically if they do burn



Landscape Evaluation

- Change in landscape mosaic
- Grassland being converted to a shrubland
- Will not be complete
- Consequences for biodiversity unclear
  - Kangaroos like grasslands

Key points arising from Case Study

- Landscape mosaics are dynamic
- Current patterns may be the consequence of past events
- Changes happen slowly but can push systems beyond thresholds into new steady states
- Landowners cannot always do what should be done – even if it is in their own self-interest

Case Study 4: There can be an imbalance between those carrying out restoration and those benefiting from restoration

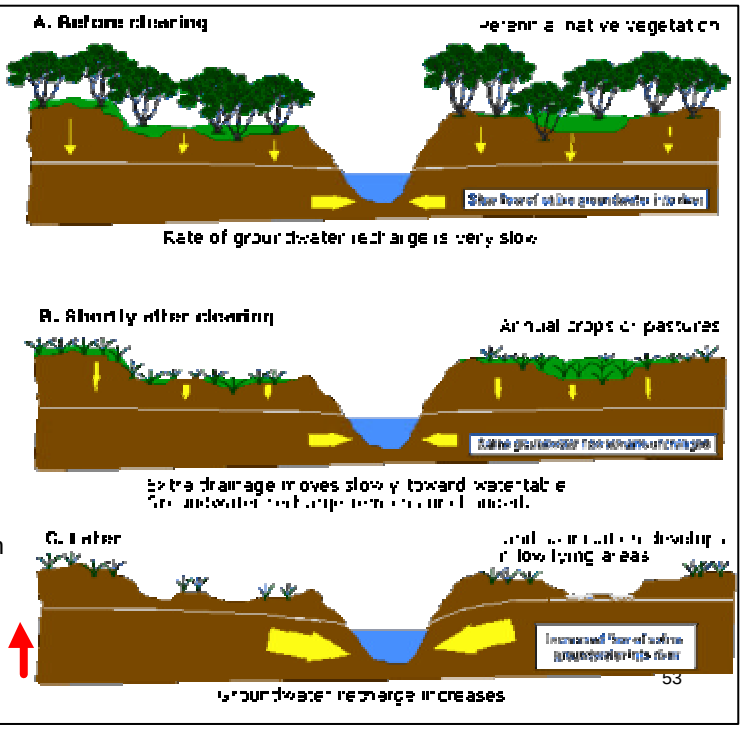
(should there be payments for ecological services provided?)

Case Study 4 Salinity – Australia

Salinity – some background

- Salinity is caused by changes to the hydrological cycle
- Example: if deep-rooted vegetation cleared or replaced by shallow rooted vegetation
- This reduces evapo-transpiration
- This causes water tables to rise
- Problems if water tables
  - Reach within 2 m of surface and
  - Water is saline (because of sediments or “cyclic” salt)

Rainfall equal or Less than evapotranspiration



Rainfall greater than evapotranspiration

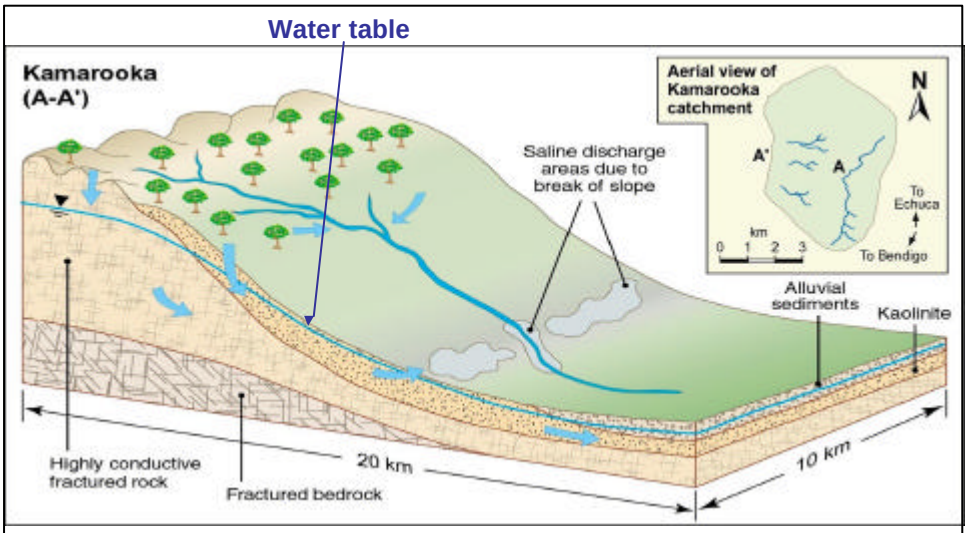
53

Consequence: (1) lower lying areas become saline
(2) streams become saline

Some background on some salinity-prone areas

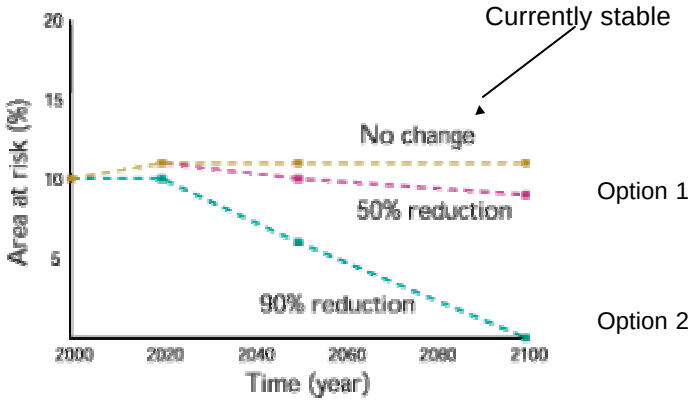
- Are privately owned farmland
- Farms mostly >3000 ha
- Population density low
- Cleared for agriculture <<100 years ago
- Rainfall zones vary from < and >600 mm
- Farm incomes range from low – modest

  (vary with international commodity price cycles; no subsidies)



Site 1: Currently used as pasture with some limited cropping

Model likely future developments



Options

1. Replace all annual pasture with deep-rooted lucerne
   - Gives 50% reduction in recharge and slight change in area
   - Increases farm income by 40%

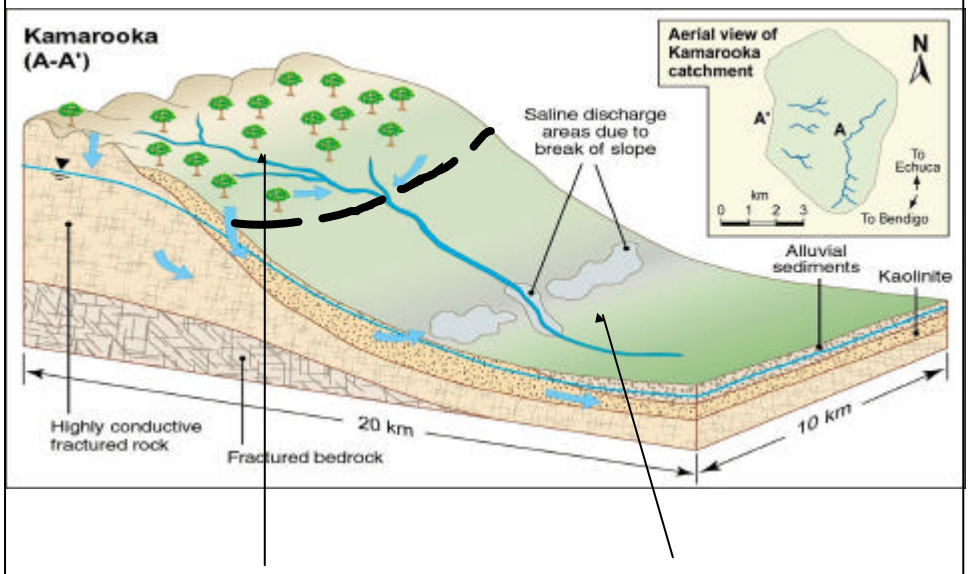
2. Plant trees over 80% of top of catchment
   - Gives 90% reduction in recharge and removes risk
   - Major reduction in farm income

Questions

- Should the area be restored (is only 10% salinised and stable)?

Questions

- Should the area be restored (is only 10% salinised and stable)?
- Who should pay?
  - Landowner?
  - government?

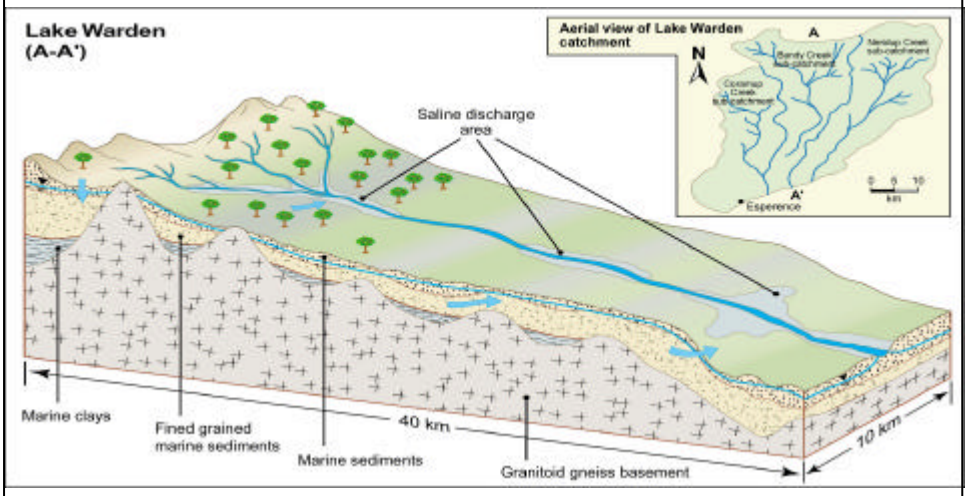


Landowner 1
(pays)

Landowner 2
(benefits)

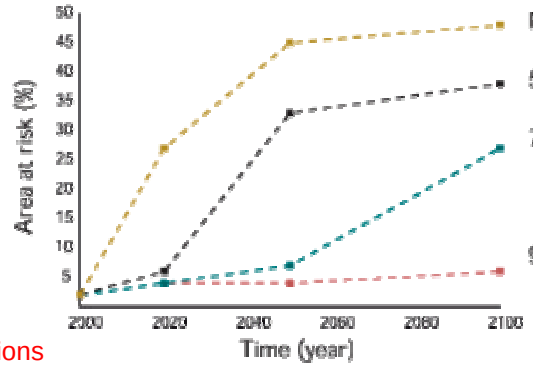
Question

- Should the area be restored?
- Who should pay?
  - Landowner?
  - government?
- What should be done?
  - Trees as a new crop (pulpwood)
    - Species
    - Density
    - Location in watershed?
  - But only in 600+ mm rainfall zone



Site 2: Currently used for annual pastures (67%) and cropping (33%)

http://audit.ea.gov.au



Options

1. No action: but 45% salinized by 2050
2. Change all to perennial pasture
   - 50% reduction in recharge – but still severe problem
   - slight improvement in farm income
3. Change all pasture to perennial pasture and all cropland to trees
   - 75% reduction in recharge – but problem only delayed
   - 25% reduction in farm income
4. Change to all but 10% trees
   - 90% reduction in recharge but unprofitable?

Questions

- A more serious problem - Should the area be “restored”?
- What should be done?
- Who should pay?
  - Landowner?
  - Downstream stakeholders?
  - Government?

Landscape Evaluation

- Change in landscape mosaic
- Low-lying areas become saline but upland areas unaffected
- Where topography level and clearing is intense even small forest remnants affected by rising water tables
- Mobilised salt increases salinity in streams
- Many biota lost?

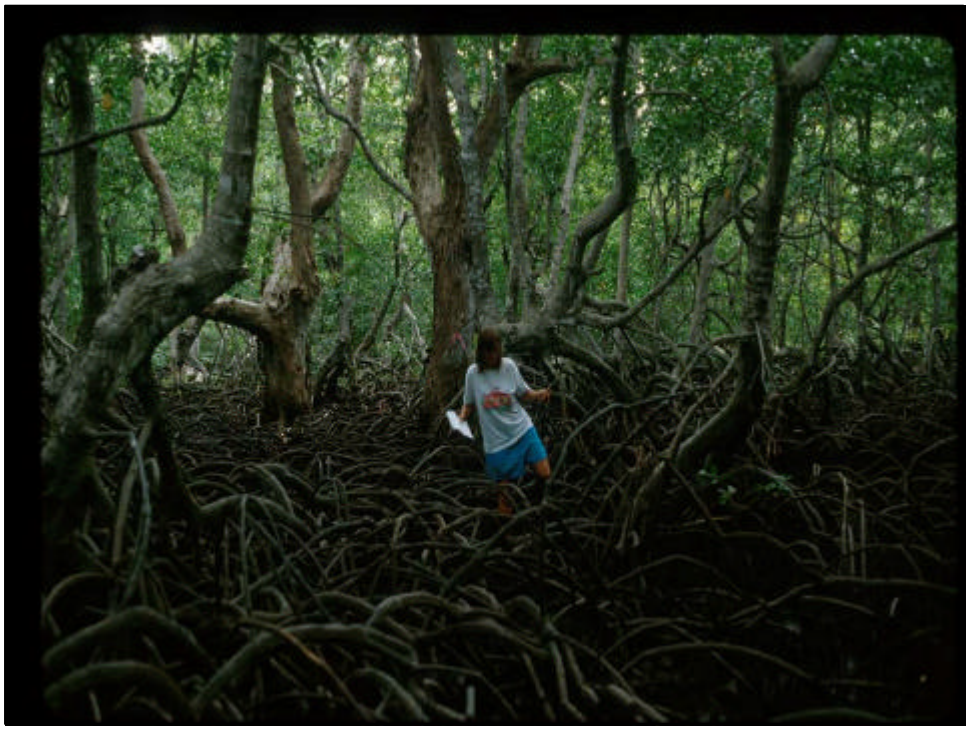
Key point arising from Case Study

- Some forms of landscape degradation will not be solved by a “do-nothing but protect” it approach.
- In (some? all?) cases the beneficiaries of restoration should share the costs of treatment
- But
  - What mechanism?
  - how much of the cost?

Case Study 5: sometimes benefits of restoration are self evident and land owners are willing to pay all costs

Background

- Mangroves are ecologically important because
  - they protect coastlines
  - Act as key breeding areas for coastal fisheries
  - Provide many goods and other services for coastal communities
- However, many are being cleared
  - For shrimp/prawn farms
  - timber
  - Real estate etc



Public Interest

Source: The Star newspaper, Malaysia

Focus 31

Save mangroves to fight tsunamis

GLOBAL TRENDS

Natural barriers against tsunamis

Nation 21

Mangroves can protect coasts

Tsunami Aftermath

Background to mangrove restoration by village people in the Philippines

- Reforesting cleared land
- Usually at a small scale
- Have used only a few of the many mangrove species present
- These species (*Rhizophora spp*.)
  - Useful
  - Seed easy to get and plant

Outcome

- Seedlings mostly survive
- Grow up and close canopy
- Form stable new forest
- Can harvest timber products within a few years

Why is it successful?

- A scarcity of timber (especially for fish traps)
- Cheap to implement (no need for finance)
- Traditional knowledge sufficient
- A “market” for the forest product
- Quick financial return

But other reasons too

Reasons for planting mangroves (n = 156)

Motive	Percent
Storm protection	47
Construction wood	43
Told to plant by officials	13
Fuel wood	11
Tenure security	10
Capital investment	10
Other construction wood	6
Paid to plant	4
Land speculation	3
Amusement	3
Ecological reasons	2

Why was it successful? (continued)

- If so successful – why not everywhere?
  - Many neighbours waited until initial planters had received a cash return before copying
  - Some areas have no “vacant” land
  - Some sites still have sufficient mangrove resources

(Question: must degradation be complete before restoration is of interest?)

Landscape Evaluation

- Deforested areas become reforested
- Coastlines protected from erosion
- Habitats re-created and biodiversity enhanced

Key points arising from Case Study

- Restoration action prompted by resource shortage
- Used simple techniques
- Costs low
- Self sufficient – no need for external inputs (of money or scientific knowedge)
- Rapid results and financial feedback

Case Study 6: Restoration may sometimes need to be done in stages (for ecological reasons)

Case Study 6: Reforestation in Vietnam

Background

- Many areas of Vietnam have been degraded over the last 50 years
- This caused by;
  - Poverty
  - Land shortages
  - Poor administration
  - Shifting cultivation
  - War
- Consequence – large grassland areas

Hai Van Pass: Central Vietnam 1975

What was done

- Grassland sites difficult to replant
  - Infertile soils
  - Grass competition
  - Wildfires
- Foresters use Acacia species because tolerant of poor soils
- These shade out grasses
- Then under-plant with several higher value native species

Outcome

- Able to selectively harvest the Acacia after 6-8 years
- This
  - Generates a cash flow
  - Pays for more reforestation (enlarges area treated)
  - Also creates canopy openings allowing high value species to grow
  - Hence creates species-rich native forest

Why did this occur?

- Land was available and uncontested
- Sufficient funds and labour were available to initiate project
- Acacia seed was easy to get
- Tree growth was rapid even on poor sites
- There is a good market for firewood
- That is, feedback was strong and encouraging
- There was interest in upgrading to higher-value trees

Landscape Evaluation

- Landscape mosaic changed
- A forest patch created
- Current habitat relatively simple but probably attractive to seed-dispersing birds

Key points arising from the Case Study

- Sometimes need a small cash input to get things started
- Then - success breeds success
- Sometimes need a two-stage approach
- Exotic species can facilitate restoration of native species

Case Study 7: Restoration may sometimes need to be done in stages (for economic reasons)

Case Study 7: Burma

Background

- Mt Popa temple area becomes degraded after 1945
  - Firewood collectors
  - Hunting
  - Agricultural encroachment
- In 1970 Forestry Department
  - plants some eucalypts
  - Guard posts (manned by paid villagers) to limit illegal logging
  - Underplants eucalypts with native species

Outcome

- Trees grow well
- Guards successively prevent illegal logging
- UNDP provides piped water to village community
- People begin to use eucalypts for fuelwood
- Residual forest of 3,200 ha grows to 13,000 ha

Why did this occur?

- Site not so degraded that tree growth not possible
- Eucalypts grew well – rapid yield
- Outside agencies had important role
  - Limited further degradation (via guards)
  - Provided seedlings
  - Funded initial tree planting
  - Provided water supplies and other village benefits

Landscape Evaluation

- Area of forest increased
- Complexity of forest enhanced
- Habitats for new species?

Key points arising from the Case Study

- Despite degradation and a loss of resources nothing happened until State intervened
- Due to lack of tenure? Land was seen as common property?
- A small intervention (guards, seedlings, knowledge) was sufficient to initiate much larger restoration effort

Question: might this have occurred anyway in the absence of outside help?

Case Study 8: Not all technical solutions are always appropriate

Case Study 8: Lake Chad Basin

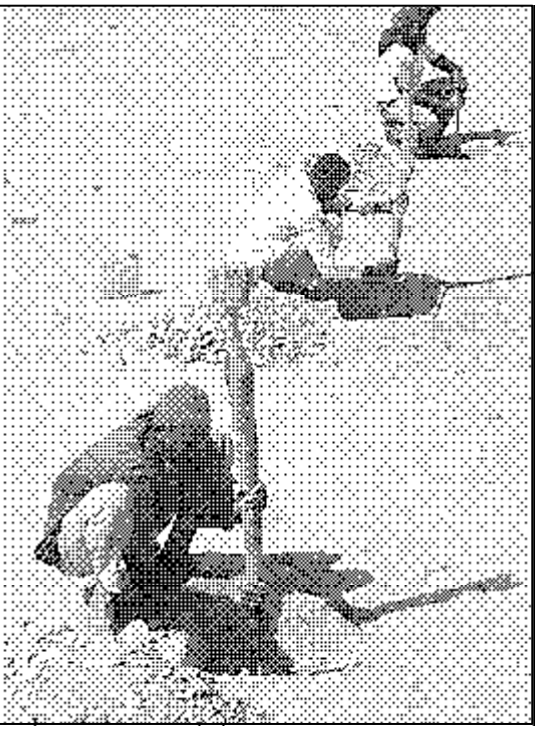
Background

- Lands degraded by
  - cotton farming,
  - shifting cultivation,
  - overgrazing,
  - firewood harvesting and
  - high population pressure
- The project wanted to explore various reforestation techniques

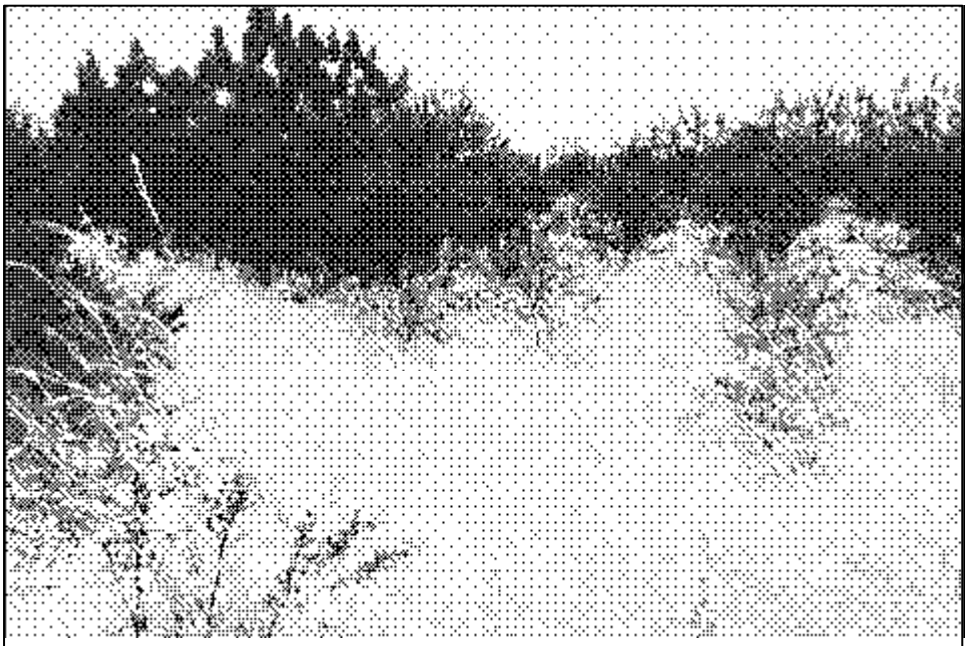
What was done

- Trials designed using past farmer experiences
- Test various tree species and planting techniques
  - Separate trial plantings
  - Plantings incorporated into existing agricultural systems
- Test various water harvesting techniques
  - Ploughing US$384 ha
  - Small dams US $268 ha
  - Planting holes US$134 ha
  - “Zai” method US$ 317 ha
- Work done by hired labour

Tree planting
in Lake Chad Basin



Checkerboard pattern traps water



Growth after 4-6 years

Outcomes

- Encouraging results
- Scope for using native and exotic tree species
- Scope for re-vegetating with a wide variety of species yield various products
  - Fuelwood
  - Fodder
  - Fruits
  - Medicines etc
- BUT
  - Methods expensive and covered only small areas
  - Inadequate involvement of farmers in project (so results might not be used?)

Landscape Evaluation

- Too small to have significant landscape consequence?

Key points emerging

- What role for high cost interventions?
- What role for top-down interventions?

Original questions to be addressed

- How does the landscape mosaic influence how we might carry out restoration?
- How can socio-economic circumstances affect restoration options?
- What lessons can we learn from past attempts at restoration?
- What are ways of evaluating social and cultural consequences of restoration?

What are indicators of socio-cultural “success”?

- Livelihoods
- Community structures and Governance
- Knowledge base

What are indicators of socio-cultural "success"?

1. Livelihoods

- Stable human populations
- Stable market prices for (agricultural) goods being produced
- New markets for goods and services arising from restoration
- Adequate food supply and standard of living
- Stable land use pattern
- Equitable tenure system – equity of access
- Appropriate balance between subsistence crops and cash crops
- Increasing economic options

What are indicators of socio-cultural "success"?

2. Community structures and Governance

- Development of a common vision
- Increased public participation in decision-making and extension
- Use of local organisations for decision making and regulation to prevent further degradation (i.e. selective decentralisation)
  - Rules of access to resources
  - Harvesting rates
  - Protection zones

What are indicators of socio-cultural “success”?

3. Knowledge base

- Increased public ecological awareness
- Increased knowledge about appropriate technologies and solutions (based on traditional knowledge when relevant?)
- Stable (i.e. sustainable) rate of fuelwood or other resource consumption
- Stable rate of water usage
- Active encouragement of innovation
- Increased knowledge of market prices for products from restoration (goods AND services)
- Replication of ideas by neighbours