SUSTAINABILITY ANALYSIS APPROACH TO THE MANAGEMENT OF SIX NEW ZEALAND LAKES

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PRESENTATION COVERAGE

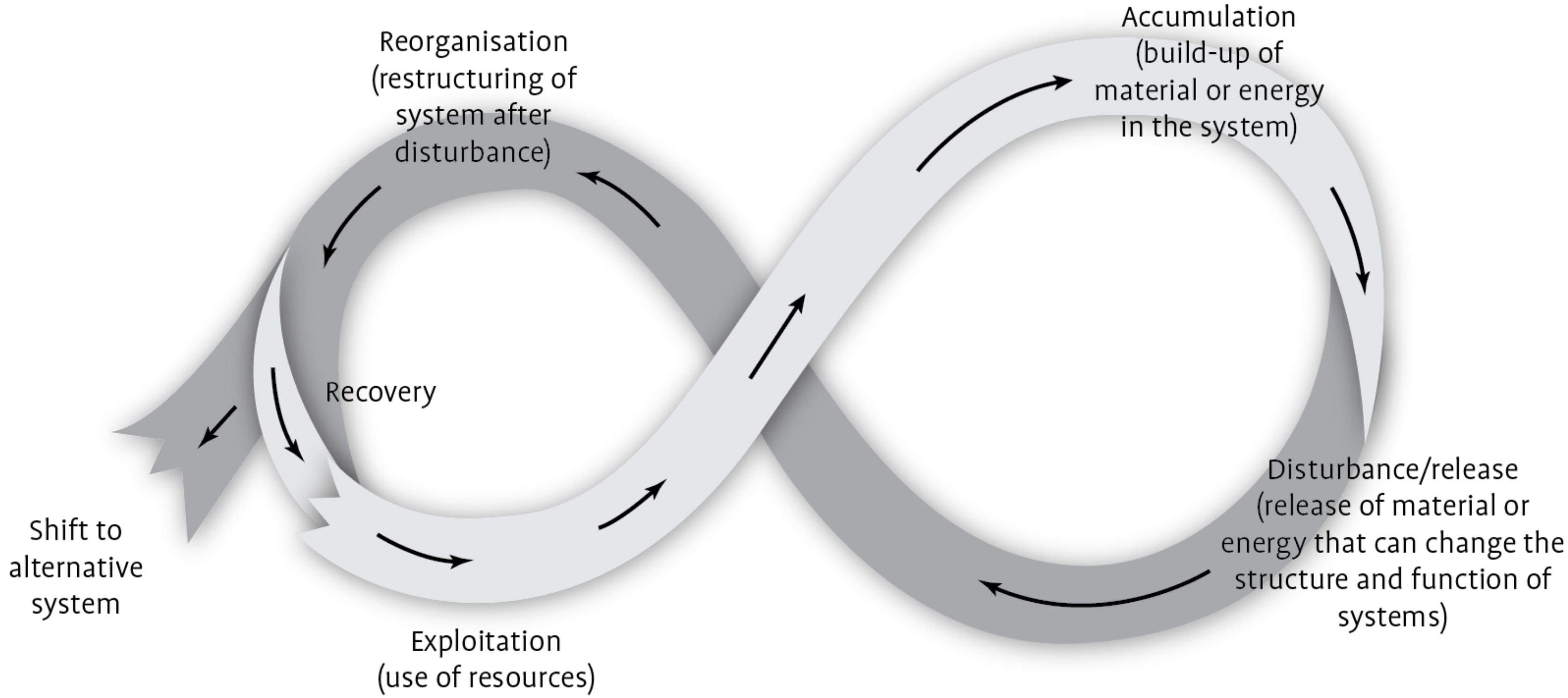
- Sustainability framework based on:
  - failure pathways
  - critical variables and thresholds
  - adequacy of management interventions
- Past applications
  - CWMS, Te Waihora / Lake Ellesmere restoration
- Application to Six New Zealand lakes
  - Brunner, Taupo, Rotorua, Omapere, Te Waihora, Waituna

ADAPTIVE CYCLE

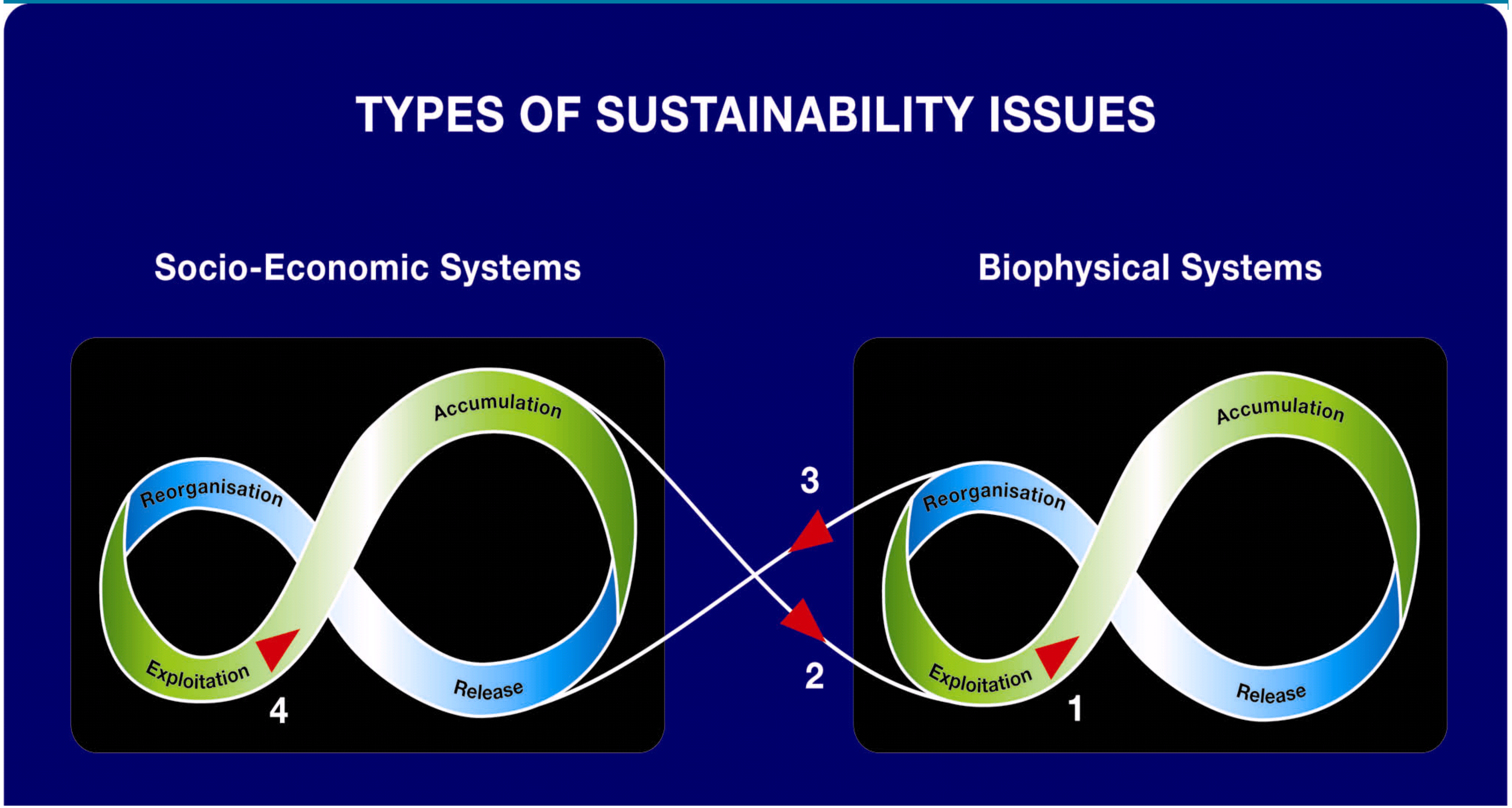
Four phases:

- Exploitation – the use and harvesting of resources
- Accumulation – the storage of material or energy in the system
- Release – disturbance of the system
- Reorganisation – restructuring of the system after disturbance (or shift to alternative state)

ADAPTIVE CYCLE



Source: Adapted from Gunderson and Holling 2002

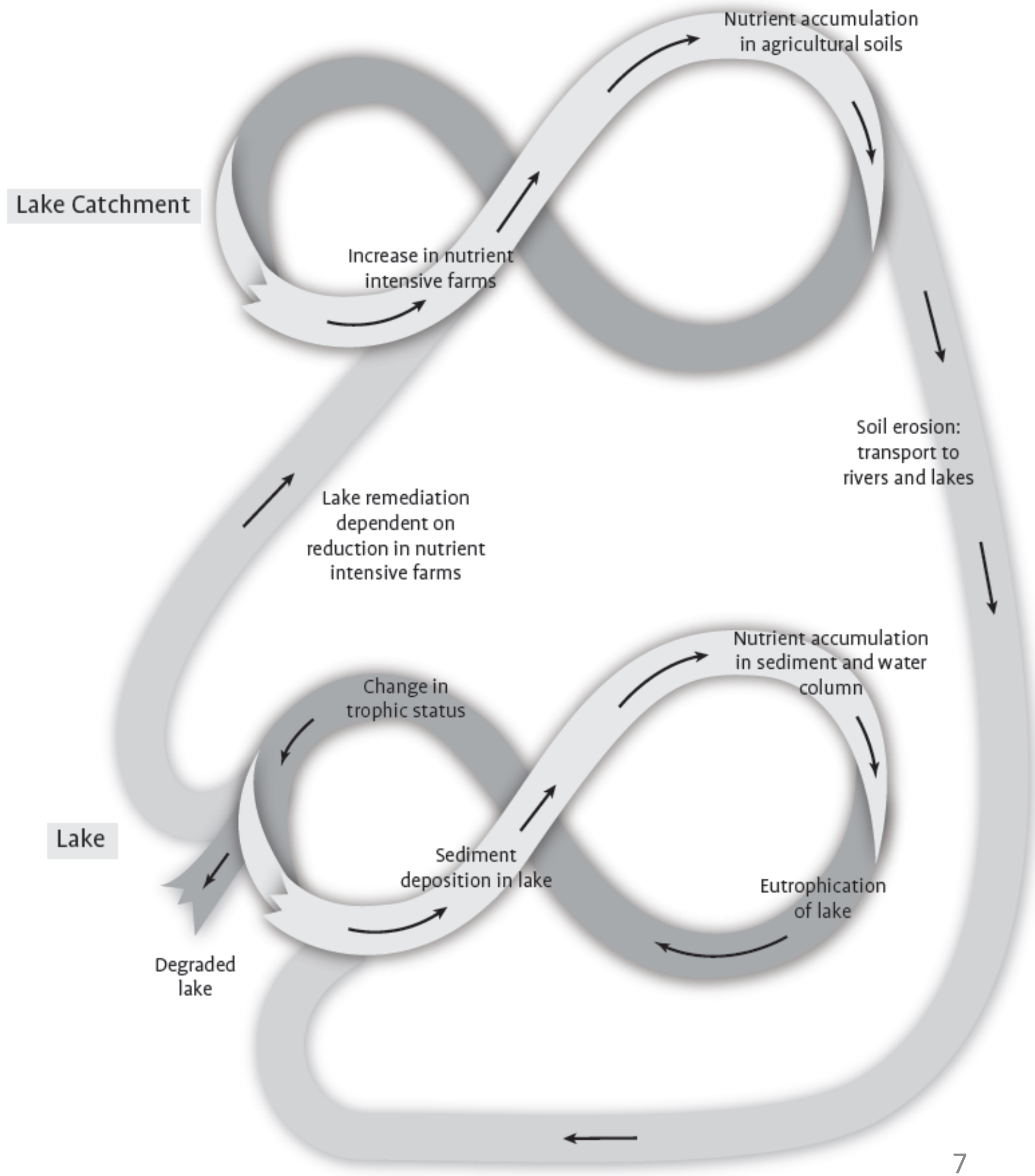


1. Capacity of the Biophysical System to be maintained
2. Capacity of the linkages of the Socio-Economic System to the Biophysical System
3. Capacity of the linkages of the Biophysical System to the Socio-Economic System
4. Capacity of the Socio-Economic System to be maintained

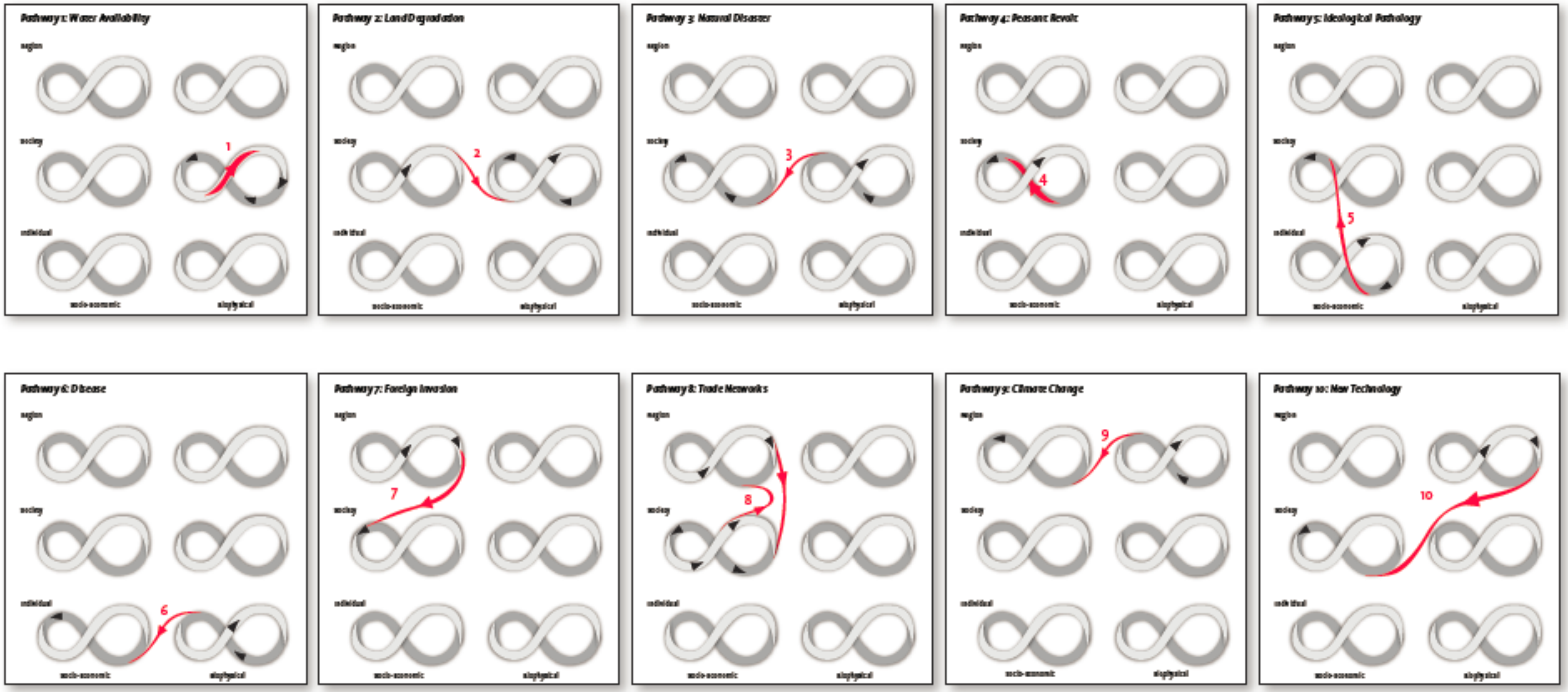
EUTROPHICATION: ADAPTIVE CYCLE

- ***Exploitation of catchment***: increase in nutrient-intensive farms
- ***Accumulation in catchment***: nutrient levels in agricultural soils
- ***Release in catchment***: soil erosion and transport of nutrients to rivers and lakes
- ***Accumulation in lake***: nutrients in lake sediments and water column
- ***Disturbance in lake***: eutrophication in lake
- ***Reorganisation in lake***: degraded lake unless reduction in nutrient-intensive farms
- ***Reorganisation in catchment***: reduction in nutrient-intensive farms

EUTROPHICATION: ADAPTIVE CYCLE



COLLAPSE PATHWAYS IN NESTED ADAPTIVE CYCLE FRAMEWORK

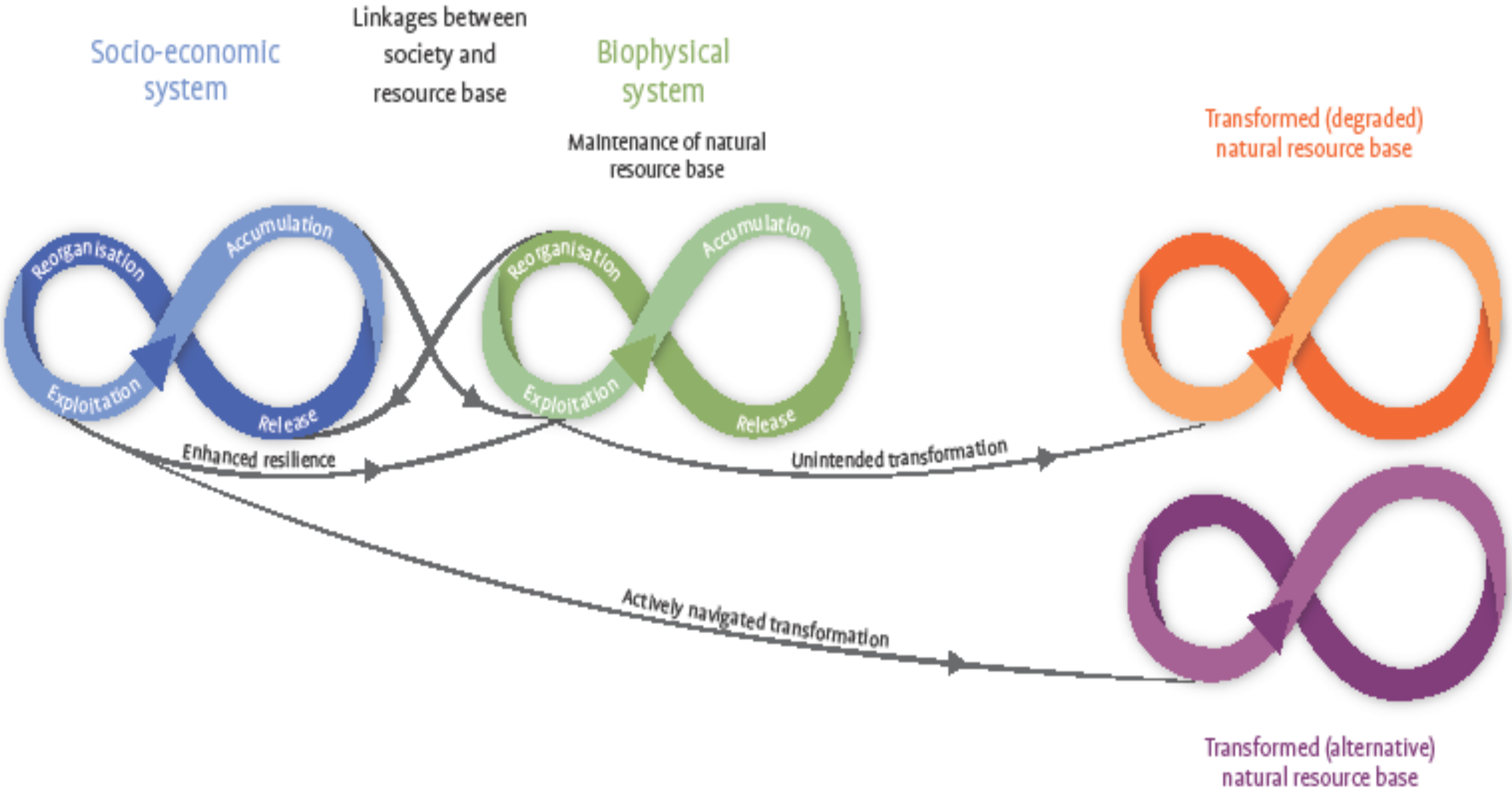


CATEGORISATION OF FAILURE PATHWAYS

SCALE	BIOPHYSICAL MAIN-TENANCE	SOCIO-ECONOMIC IMPACT ON BIOPHYSICAL	BIOPHYSICAL IMPACT ON SOCIO-ECONOMIC	SOCIO-ECONOMIC MAINTENANCE
Region	Climate variability	Climate change	New technology changing social relationships	Conflict: Hostile neighbours Integration: Loss of trade networks
Society	Cumulative depletion of natural resources	Cumulative environmental degradation	Natural disasters	Conflict: Internal warfare Integration: Diminishing marginal productivity
Individual	Local natural resource depletion	Local environmental degradation	Disease	Individual commitment to society

STEWARDSHIP DECISION MAKING

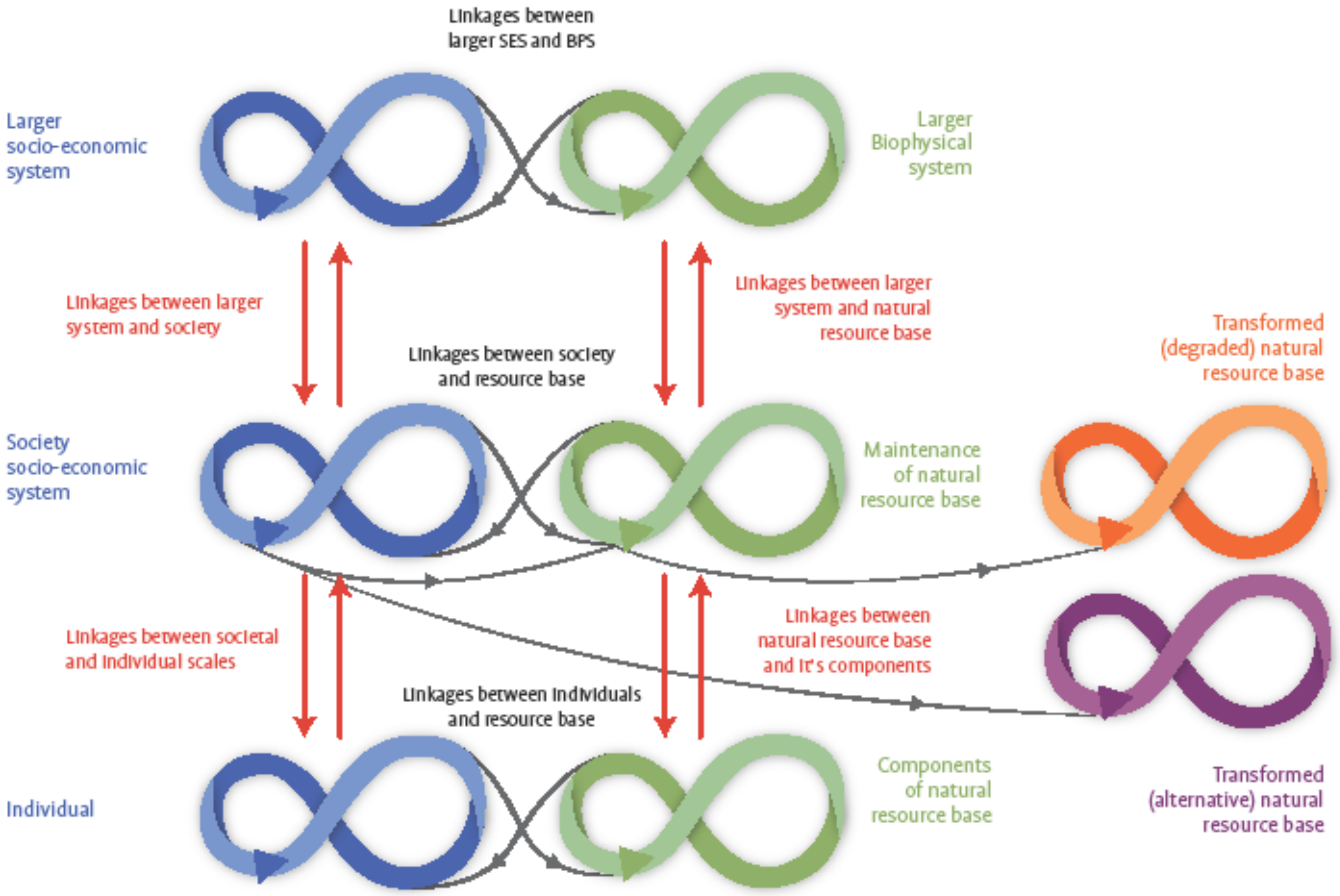
- Enhancement of resilience of natural resource system
- Transformation to degraded natural resource base
- Actively navigated transformation to an alternative system



RESOURCE OUTCOMES FOR COUPLED SOCIO-ECONOMIC AND BIOPHYSICAL SYSTEMS

STEWARDSHIP STRATEGIES

- **Chapin's approaches:** reduce vulnerability, enhance adaptive capacity, increase resilience, enhance transformability
- **Framework for classifying approaches to sustainability:** placed in context of nested adaptive systems
- **Classification of sustainability strategies:** allocation of approaches to appropriate scale or linkage



FRAMEWORK FOR CLASSIFYING APPROACHES TO SUSTAINABILITY

CLASSIFICATION OF SUSTAINABILITY STRATEGIES

LEVEL	SOCIO-ECONOMIC SYSTEM	LINK SES AND BPS	BIOPHYSICAL SYSTEM	TRANS-FORMATION
LARGER SCALE	Adjust governance	Sustain cultural connections	Sustain slow variables	Enhance diversity
LINKAGE TO LARGER SCALE	Stabilise feedback from SES		Stabilise feedback from BPS	
SOCIETY AND RESOURCE BASE	Enhance learning capacity	Explore options. Reduce exposure	Renew degraded systems	Create new systems
LINKAGE TO SMALLER SCALE	Engage stakeholders			
SMALLER SCALE		Experiment to test understandings	Pay attention to vulnerable components	Foster innovation

APPLICATION TO WATER MANAGEMENT IN CANTERBURY

- Shift in approach

  - from storage strategy to address to water availability

  - to integrated water management strategy

- Broader considerations

  - consideration of failure pathways

  - consideration of sustainability strategies

LEVEL	SOCIO-ECONOMIC	LINKAGES SES AND BPS	BIOPHYSICAL SYSTEM	TRANS FORMATION
Canterbury Region				Storage with alpine rivers
Linkage to region				
Catchment		Allocation limits	Run-of-river supply	
Linkage to subcatchment				
Subcatchment			Environmental flow for river reach	
Linkage to individual				
Individual	Consent			

LEVEL	SOCIO-ECONOMIC	LINKAGES SES AND BPS	BIOPHYSICAL SYSTEM	TRANS FORMATION
Canterbury Region	Regional Committee			Storage with alpine rivers
Linkage to region	Regional implementation		Inter-basin transfers	
Catchment	Zone Committee Moratorium on consents	Allocation limits Reallocation of consents.	Run-of-river supply	Groundwater storage
Linkage to subcatchment	Zone implementation		Piped distribution	
Subcatchment	Water User Group	Real time monitoring of total take	Environmental flow for river reach	Irrigation scheme storage
Linkage to individual	Brokerage		Real time monitoring of take	
Individual	Consent	Soil moisture monitoring	On farm irrigation efficiency	On farm storage

TE WAIHORA: SHIFT IN APPROACH

Shift from:

- Management approaches for individual values
- Attempts at multi-objective approaches generating conflicting effects

Shift to:

- Management based on nested adaptive systems
- Coordination across agencies, Ngai Tahu and community
- Focus on vulnerable components (resilience assessments)
- Modeling of alternative scenarios for outcomes
- Guided by broader regional strategies

SUSTAINABILITY ANALYSIS OF LAKES

- What are the ***critical variables*** that lead to water quality ***failure pathways***?
- What are the current ***management interventions*** to address these failure pathways?
- Are the interventions sufficient to achieve ***sustainable*** water quality?

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CRITICAL VARIABLES ON WATER QUALITY PATHWAYS

LAKE	CATCHMENT VARIABLE	LAKE VARIABLE
Brunner	P loading in runoff	DO in bottom waters
Taupo	N loading in groundwater	Algal blooms in lake
Rotorua	N and P loading from surface and groundwater	Algal blooms in lake DO in bottom water Remobilisation from sediments
Omapere	N (baseflow) and P (peaks) from surface water	Toxic algal blooms Algae-macrophyte switching Wind mobilisation of sediments DO levels for mussels
Te Waihora	N and P loading in groundwater-fed streams Sediment from streams	Lake level and openings Wind resuspension of sediments High N, P and sediment loads Loss of macrophytes
Waituna	N and P loading from surface water with groundwater contribution Sediment from streams	Risk of macrophyte to algae “flip” Lake openings Wind resuspension

CURRENT MANAGEMENT INTERVENTIONS

LAKE	PHYSICAL ACTIVITIES	REGULATORY ACTIVITIES	ORGANISATIONAL ARRANGEMENTS
Brunner	Voluntary farm plans	*Revised Regional Plan* *P application limits*	NZ Landcare Trust Dairy NZ farm plans
Appraisal: Inadequate action to achieve sustainability			
Taupo	Minor trades with Trust	Nitrogen discharge allowances Cap and Trade market in NDAs 20% target reduction in N	Lake Taupo Protection Trust ($81.5m) “Partnerships of Innovation”
Appraisal: N load greater than 20% in groundwater Long term return to 2001 levels by 2080 needs further intervention			

LAKE	PHYSICAL ACTIVITIES	REGULATORY ACTIVITIES	ORGANISATIONAL ARRANGEMENTS
Rotorua	Lake bed treatment Harvesting biomass *P flocculation in streams* *Best mgnt. practices* *Land use change to low N activities*	Reduce N: 755 to 435 t/y Deed of funding agreement ($45.5m) *Investigate nutrient trading*	Lakes WQ Society Rotorua Lakes & Land Trust Rotorua Lakes strategy group Chair in lake management Stakeholder Advisory Group
Appraisal: Significant programme underway to achieve catchment nutrient reduction and lake sediment source			
Omapere	Carp introduction to address oxygen weed Voluntary farm plans Fencing and riparian planting	Voluntary lake strategy	Lake Omapere Trust Lake Omapere project management Group
Appraisal: Recent water quality improvements due to macrophyte/algae cycling Tributary nutrient levels still exceed lake nutrient levels Inadequate actions to achieve sustainability			

LAKE	PHYSICAL ACTIVITIES	REGULATORY ACTIVITIES	ORGANISATIONAL ARRANGEMENTS
Waituna	Drainage works Sustainable milk production plans Winter grazing trials	*Region Plan Change: consents for dairy farms* *Water and Land 2020*	Lake Waituna Control Assn. Waituna Partners Group Lagoon Technical Group Waituna Liaison Committee
Appraisal: Load of 19 tN/km2/y to be reduced to 9 Load of 0.74 tP/km2/y to be reduced to 0.57 Lake openings to flush nutrients limited by salinity effects on seagrass Inadequate actions to achieve sustainability			
Te Waihora	Whakaroa Te Waihora Change in lake opening regime	Canterbury water management strategy Zone implementation programme *Regional Land and Water Plan*	Region Committee Zone Committee Ngai Tahu / ECan governance agreement Statutory agencies group
Appraisal: Current N load 2650 t/y, 2011 land use equilibrium load 4100 t/y Central Plains and other intensification: 5600 t/y Proposed solution package: 4800 t/y ($30m reduction in regional GDP) Inadequate action to achieve macrophyte lake of 800 t/y			

OVERVIEW OF SUSTAINABILITY ANALYSIS

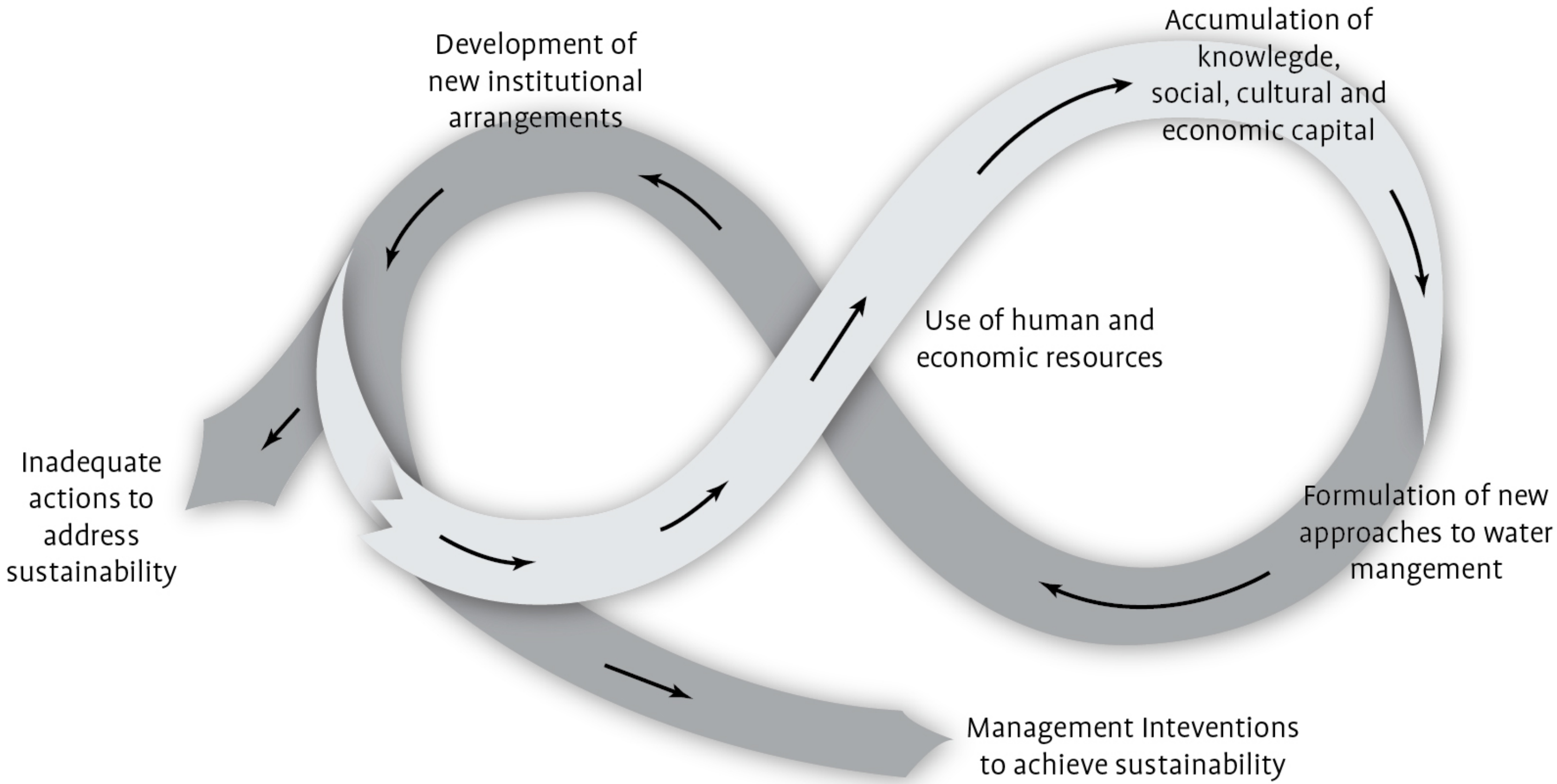
- Insufficient action in place to achieve sustainable water quality
- Emerging new approaches

  - Technical: farm plans, improved land management, riparian plantings, constructed wetlands, lake bed treatments, scientific investigations and monitoring

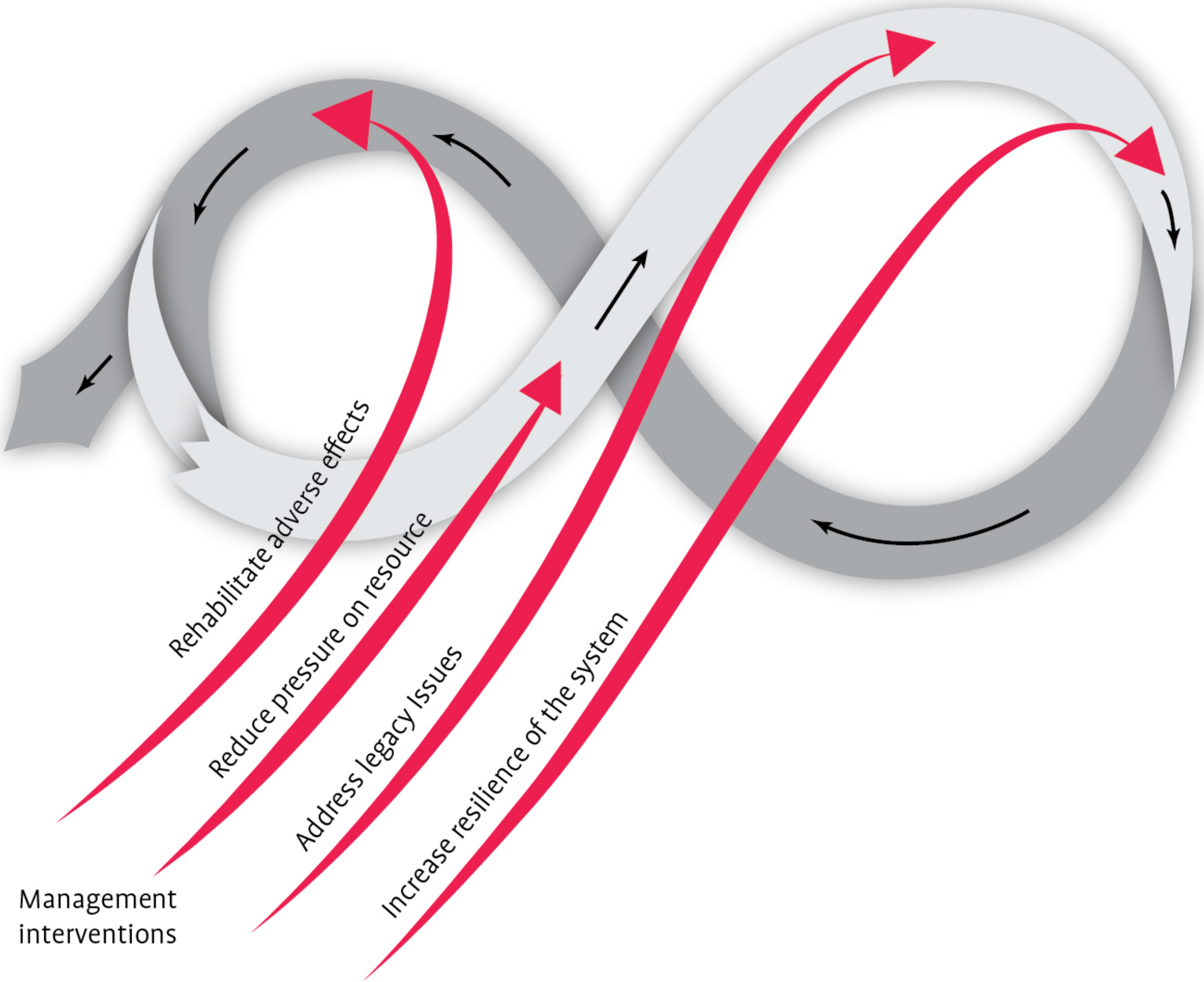
  - Regulatory: catchment limits, consent controls, non-statutory strategies

  - Organisational: partnerships, stakeholder groups, community engagement, technical groups, iwi governance arrangements, funding agreements

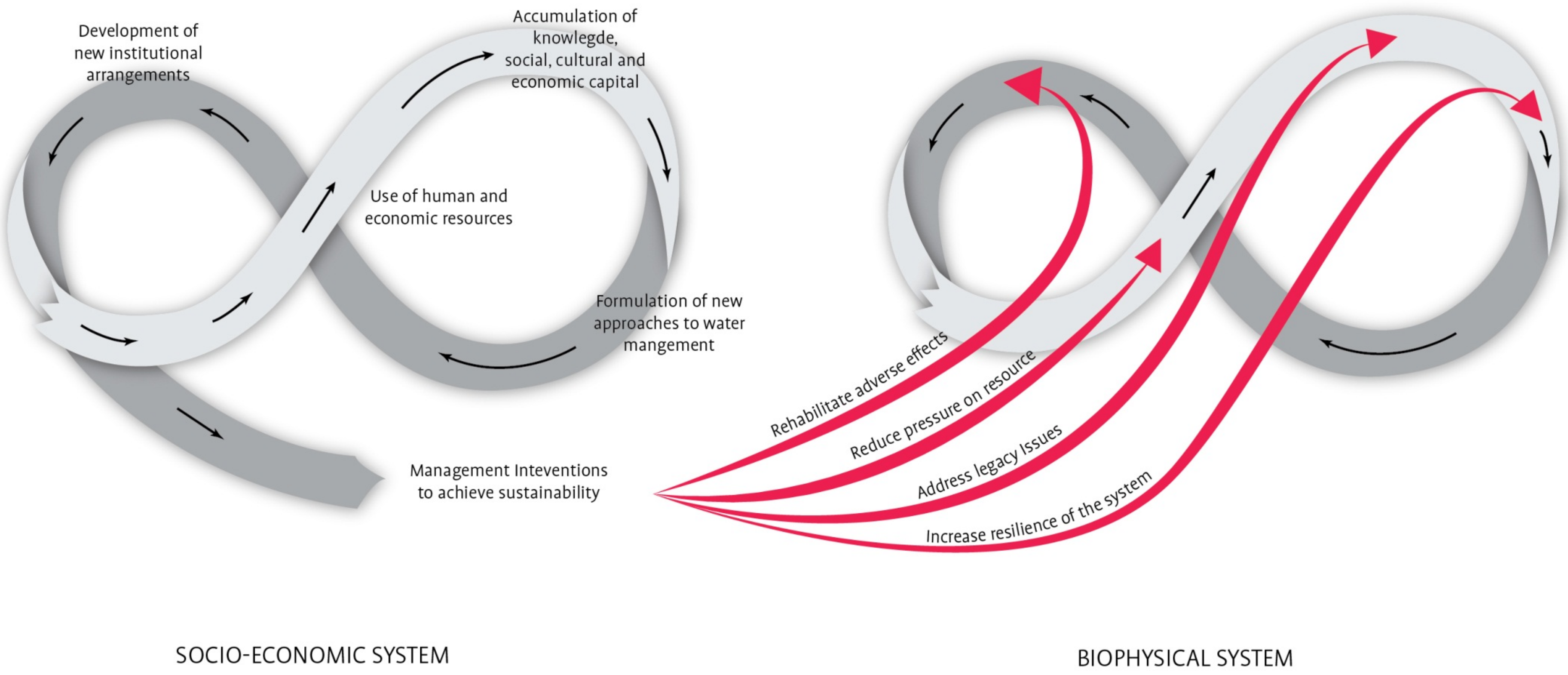
SOCIO-ECONOMIC SYSTEM FRAMEWORK TO DEVELOP MANAGEMENT INTERVENTIONS TO ACHIEVE SUSTAINABILITY



MANAGEMENT INTERVENTIONS FOR EACH PHASE OF THE BIOPHYSICAL CYCLE



MANAGEMENT INTERVENTION PATHWAYS TO ACHIEVE SUSTAINABILITY



CONCLUSIONS

- Framework for achievement of sustainability based on nested adaptive systems

  - failure pathways, critical variables and adequacy of management interventions

- Six lake case studies

  - all require reductions in current land use intensification to achieve sustainable water quality

  - some positive innovations in water management

  - need for greater management interventions

- Importance of government, community, industry partnerships

  - LGA concept of sustainable development

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MESSAGE 1

If we have reached the sustainability limits of resource use

Then further land intensification requires reduction in impacts in ***current*** land use

And

a system of impact assessment of ***new*** projects will not achieve sustainable management

MESSAGE 2

Maintaining our ***natural capital***

also requires building our ***social, cultural***
and ***economic capital***

to develop ***management interventions*** that
are sustainable