A Te Ao Māori perspective of ecosystems to explore complex multi-faceted issues and challenges in One Health

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Garth Harmsworth

(Te Arawa, Ngāti Tūwharetoa, Ngāti Raukawa)

Manaaki Whenua-Landcare Research, Private Bag 11-052, Palmerston North

HarmsworthG@LandcareResearch.co.nz

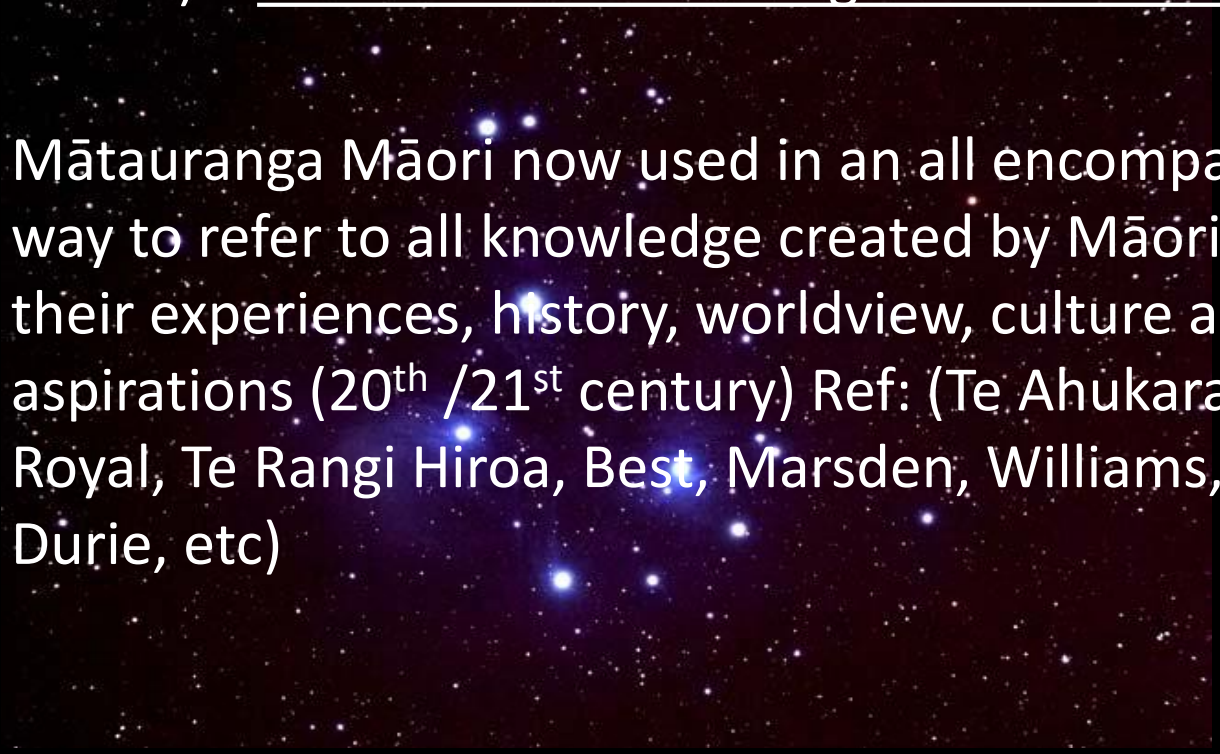
Outline of talk

1. Different knowledge systems, beliefs, world views, the nexus between Māori worldviews (Te Ao Māori) and western science
2. Ecosystem approaches – what are they? What do they tell us about integration? Whole systems?
3. A Te Ao Māori perspective of ecosystems – holistic thinking
4. Working together – interdisciplinary and transdisciplinarity
5. Complex multi-faceted challenges and issues in One health.

Mātauranga Māori

- Mātauranga Māori first used in a restrictive fashion to refer to knowledge created under the inspiration of a ‘ngā atua Māori’ (non-Christian ‘god(s)’) – the preserve of ‘tohunga Māori’ (late 1800’s) – <u>to reinforce and distinguish the Māori belief system</u>

- Mātauranga Māori now used in an all encompassing, global way to refer to all knowledge created by Māori according to their experiences, history, worldview, culture and aspirations (20th /21st century) Ref: (Te Ahukaramu Charles Royal, Te Rangi Hiroa, Best, Marsden, Williams, Mead, Barlow, Durie, etc)



Mātauranga Māori/Māori values

- Māori knowledge (mātauranga Māori) – Links back into Polynesia 5000yrs, island settlement, trans-Pacific migrations, and recent – 1000 yrs of history and knowledge in Aotearoa-New Zealand, as Māori culture evolved with the environment as part of ecosystems

Mātauranga Māori

Te Whānau Marama – Family of Light
Ngā Whetū – stars

Sun, moon, planets, stars, constellations. **Several hundred star names existed before European arrival**, compasses used to chart the winds. used to navigate: Matariki, Taumata kuku, Tautoru, Puanga, Autahi, Takarua.

- Venus - Kōpu, Tāwera, Meremere-tū-ahiahi
- Jupiter – Pareārau (pare of a hundred lovers)
- Mars – Matawhero
- Mercury – Whiro
- Sirius – Takurua
- Orions Belt – Tautoru
- Arcturus – Ruawāhia
- Pleiades – Matariki (Maramataka, Pipiri, the first month of the Māori lunar calendar is marked by the star cluster Matariki). Rising star of Puanga (Rigel of Orion), The task of Puanga is to strive with Matariki (the Pleaides) to gain possession of the yr.
- Vega – Whānui
- Rigel – Puanga
- Antares – Rehua (Maramataka, Hahikea is identified as the rising star of Rehua (Antares)
- Altair – Poutūterangi (Maramataka, signals maturing of crops)
- Canopus – Atutahi, Atuatahi

<u>Comets</u>

- Named Auahiroa, auahitūroa (Meaning ‘long smoke trails’, upokoroa – were common names for comets

<u>Meteors</u>

- Matakōkiri, tumatakōkiri, kōtiri, kōtiritiri – Meteors were interpreted to convey fire to Earth, or stars the sun or moon had struck down. Bright meteors were seen as a good omen, while dull meteors were a bad omen.

Mātauranga Māori/Māori values

- Pleiades
- Mata-ariki, Matariki (Taurus constellation) associated with winter solstice (21 June) in the tail of the Milky way in the last days of May /early June, just before dawn. After the full moon rose. Links to bright star Whānui (Vega) Surrounded by 6 daughters:
- Tupu-ā-nuku
- Tupu-ā-rangi
- Waiti
- Waitā
- Waipuna-ā-rangi
- Ururangi

Maramataka (Māori lunar calendar) to guide, planting, hunting, fishing, etc.

- Traditional growing yr into 12 lunar months, marama means moon and lunar month. Most tribes the month started with a new moon, and some tribes used a full moon (Rākaunui). 1 lunar month = ~29.5 days, between successive new moons straddles 2 calendar months. Some iwi listed 13 months.

- Pipiri (May/June) – earth and people are getting cold
- Hōngōnui, Hōngōngoi (June/July) – v cold, need to make fires to keep warm
- Here-turi-kōkā (July/August) – still cold need for fires, inanga migrate upstream
- Mahuru (August/September) – warmth beginning, vegetation, trees, time to prepare gardens
- Whiringa-ā-Nuku (Sept/Oct) – spring growth, warmth, crops planted, tuna, inanga, fish-ika are caught. Rongoa practiced.
- Whiringa-ā-Rangi (Oct/Nov) – Sun getting stronger, flowers, birds, fish
- Hakihea (Nov/Dec) – Birds, nests, land is ploughed, berries ripening, Pōhutukawa is in bloom and some crops ready for harvest
- Kohi-tātea (Dec/Jan) – Fruits are ripe, new food, gather summer fruits, etc.
- Hui-Tanguru (Jan/Feb) – hot, very warm, but towards summer end
- Poutū-te -rangi (Feb/March) – crops now harvested, maturing of crops, first kūmara harvest begins
- Paenga-whāwhā (March/April) – Vegetation stalks and stems stacked, kūmara leaves start to go brown, main crop harvests
- Haratua (April/May) – crops stored in pits ready for winter supply, time to rest, preparation for coming winter

Mātauranga Māori

- Māori philosophy and wisdom – Large body of knowledge of Polynesian origin
- Derived and translated through each generation from ancestors and elders – mainly oral
- In Aotearoa, localised specific to iwi/hapū/whānau (tribes)
- Tane journeyed to the heavens, (climbed to the highest 12th heaven) where he retrieved the 3 baskets of knowledge – Ngā Kete o te Wānanga – From which came human life:
  - tuatea (basket of light, present knowledge and future use)
  - tuauri (basket of the unknown, darkness, ritual, memory, prayer, etc)
  - aronui (the image, what we currently seek, basket of pursuit)

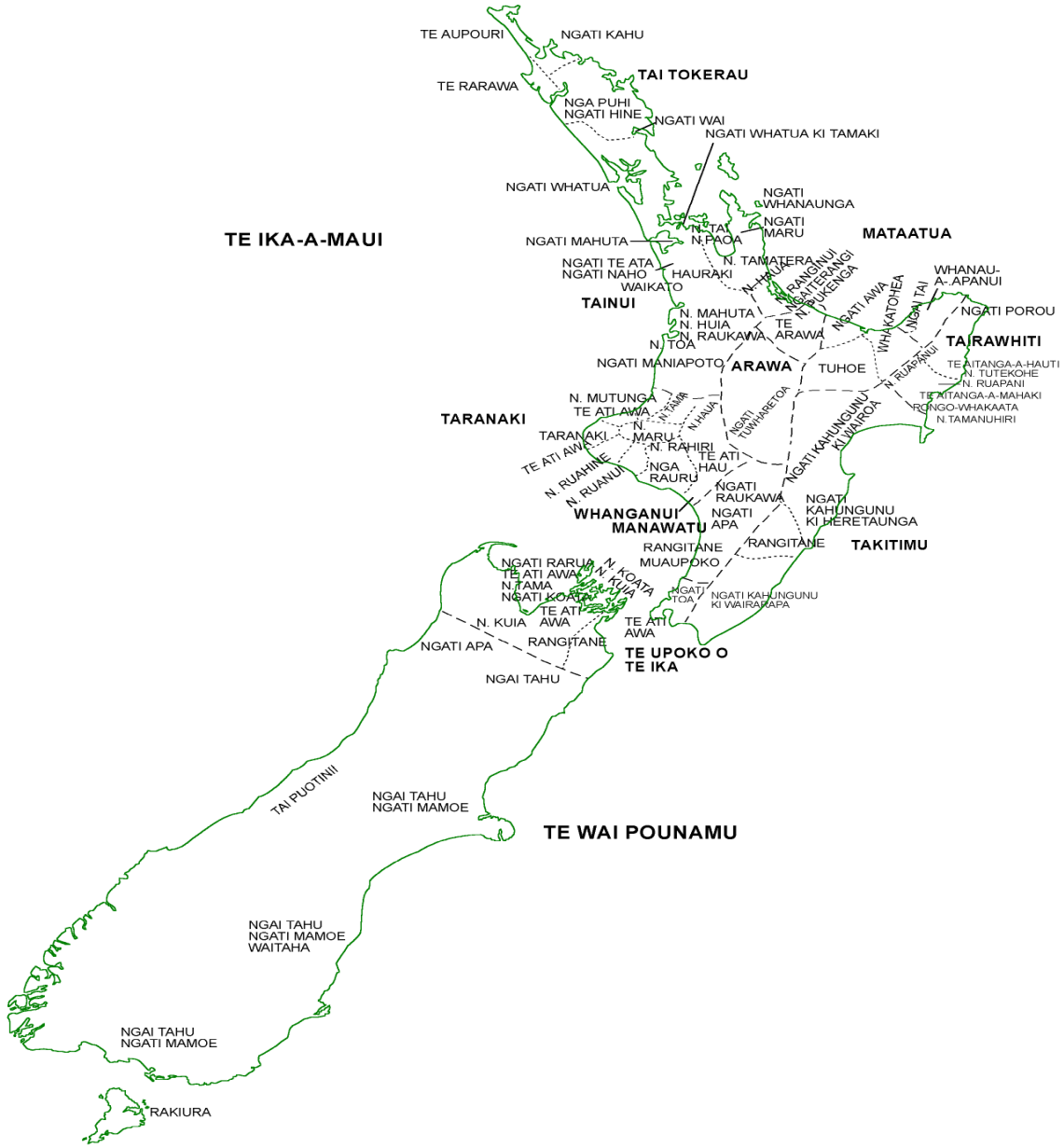
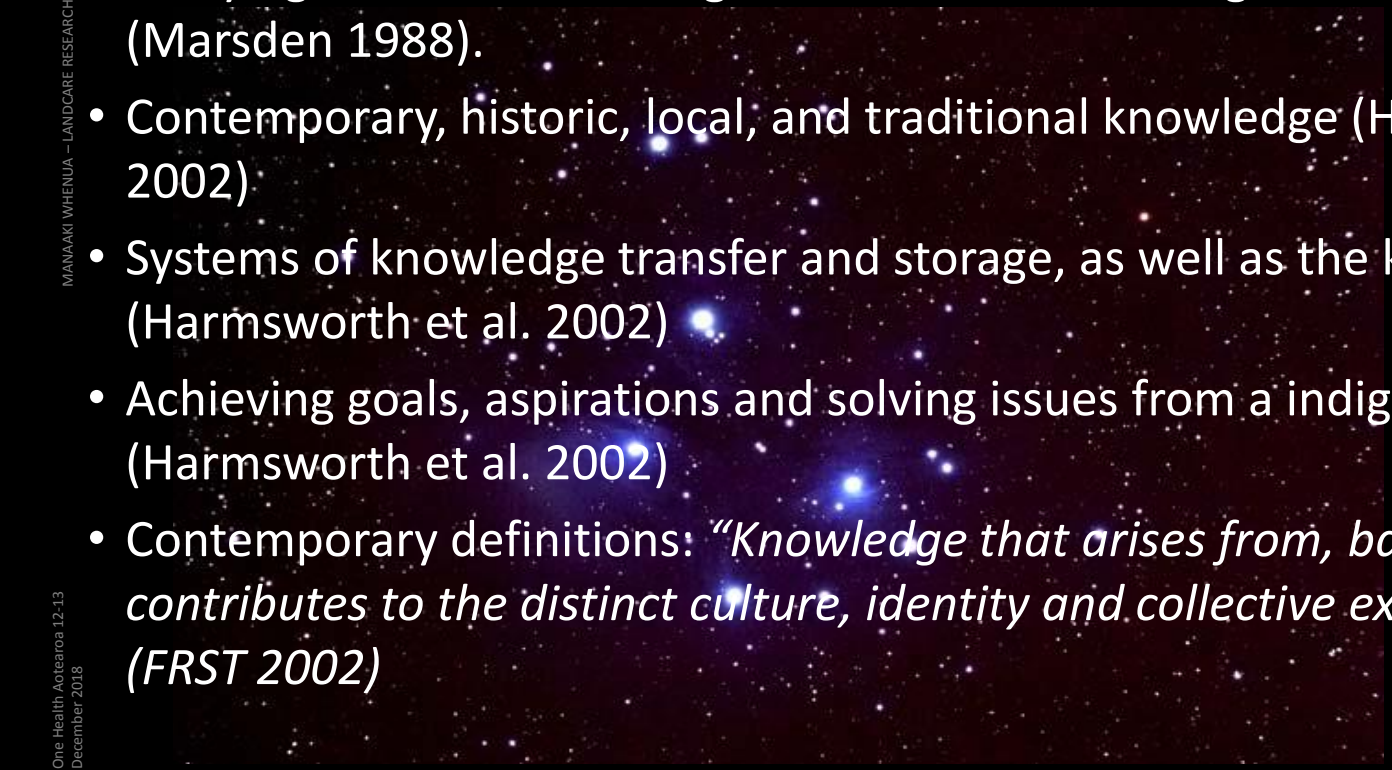


Figure 1: Location of main iwi throughout Aotearoa - New Zealand

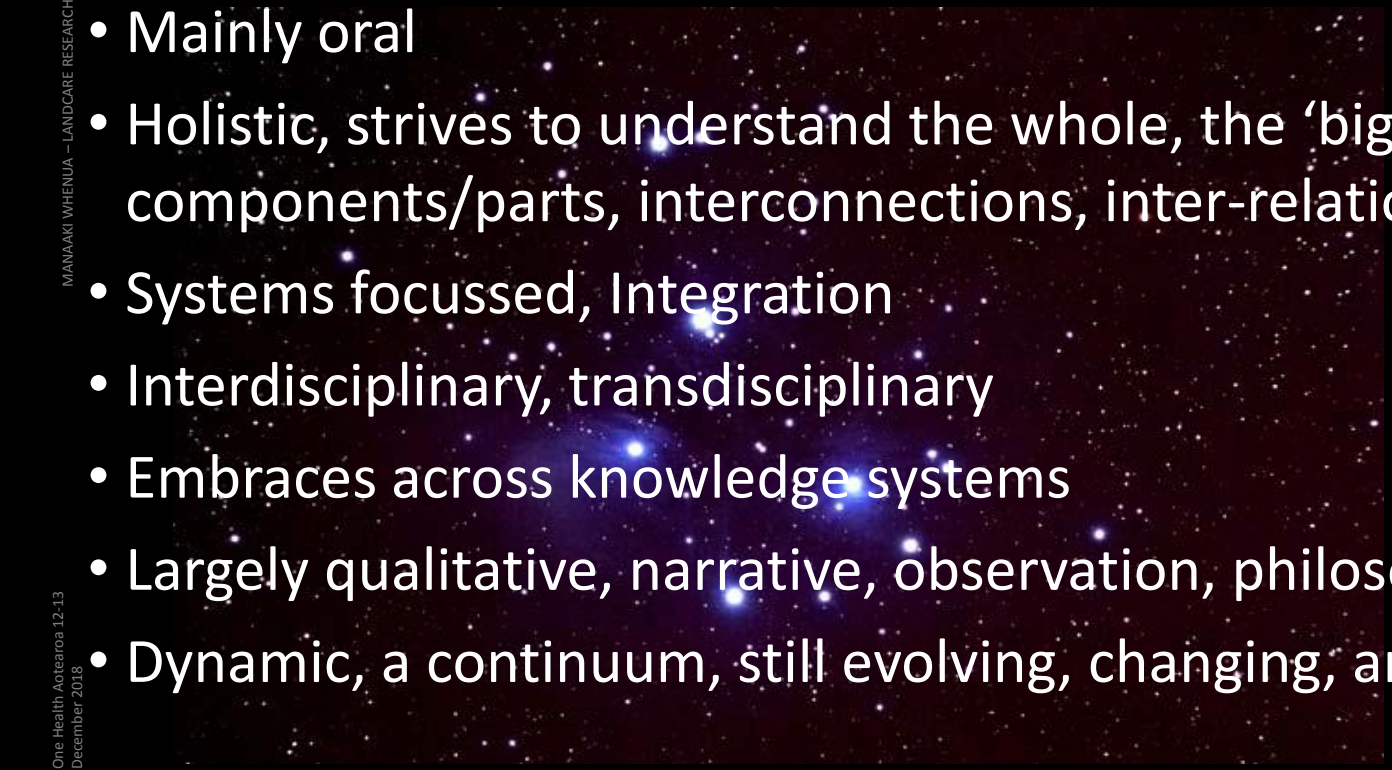
Many definitions

- Often used synonymously with wisdom and can be defined as ‘the knowledge, comprehension, or understanding of everything visible and invisible existing in the universe’ (Williams 1997).
- Encapsulates a Māori world-view and involves observing, experiencing, studying and understanding the world from an indigenous cultural perspective (Marsden 1988).
- Contemporary, historic, local, and traditional knowledge (Harmsworth et al. 2002)
- Systems of knowledge transfer and storage, as well as the knowledge itself (Harmsworth et al. 2002)
- Achieving goals, aspirations and solving issues from a indigenous perspective (Harmsworth et al. 2002)
- Contemporary definitions: *“Knowledge that arises from, based on, or contributes to the distinct culture, identity and collective experience of Māori” (FRST 2002)*



Mātauranga Māori (summary)

- Comprehend world/universe, find meaning to life
- Based on Māori beliefs (links physical and metaphysical-spiritual)
- Kaupapa Māori based
- Mainly oral
- Holistic, strives to understand the whole, the ‘big picture’, all the components/parts, interconnections, inter-relationships
- Systems focussed, Integration
- Interdisciplinary, transdisciplinary
- Embraces across knowledge systems
- Largely qualitative, narrative, observation, philosophy
- Dynamic, a continuum, still evolving, changing, and adapting



Kaupapa Māori/mātauranga Māori	Science
Origin: Polynesian origin - ~5000yrs BP Make sense, comprehend and understand the world/universe/phenomena, find meaning and balance to life systems, develop technology, solve problems. **Principles** Underlying Māori values and principles Keep the object and subject connected, use values, religion, philosophy to guide knowledge collection/creation **Holistic, integrated, subjective** Often starts with the whole 'big picture', tries to find interconnections to validate the truth, to understand the whole and find a balance between the physical and spiritual worlds	**Origin:** Greek/Egyptian/Asian (~600BC) Enquiry – Find the truth, facts, understand phenomena. Comprehend/understand the world /universe, develop technology, solve problems. **Principles** Underlying science principles Separate the object and the subject – remove myth, religion, culture, from the facts Systematic and organised enquiry to find the truth/ answers, using scientific method and process. **Objective/reductionist** Tends to be more reductionist, studies parts/components of a system in order to find answers because of complexity – requires integration to make sense of the whole and interconnections of system
Methods: Mainly oral, subjective, wānanga, hui, te reo, narratives, frameworks, concepts, observation, kaupapa Māori, experiment, observation, Knowledge 'handed down', systematic	**Methods:** Mainly written and oral, objective, hypothesis/prediction, theory, concepts, data, models, experiment, observation, repeatable, measurements, maths, universal laws, and verification, etc Knowledge documented/peer reviewed, systematic, organised

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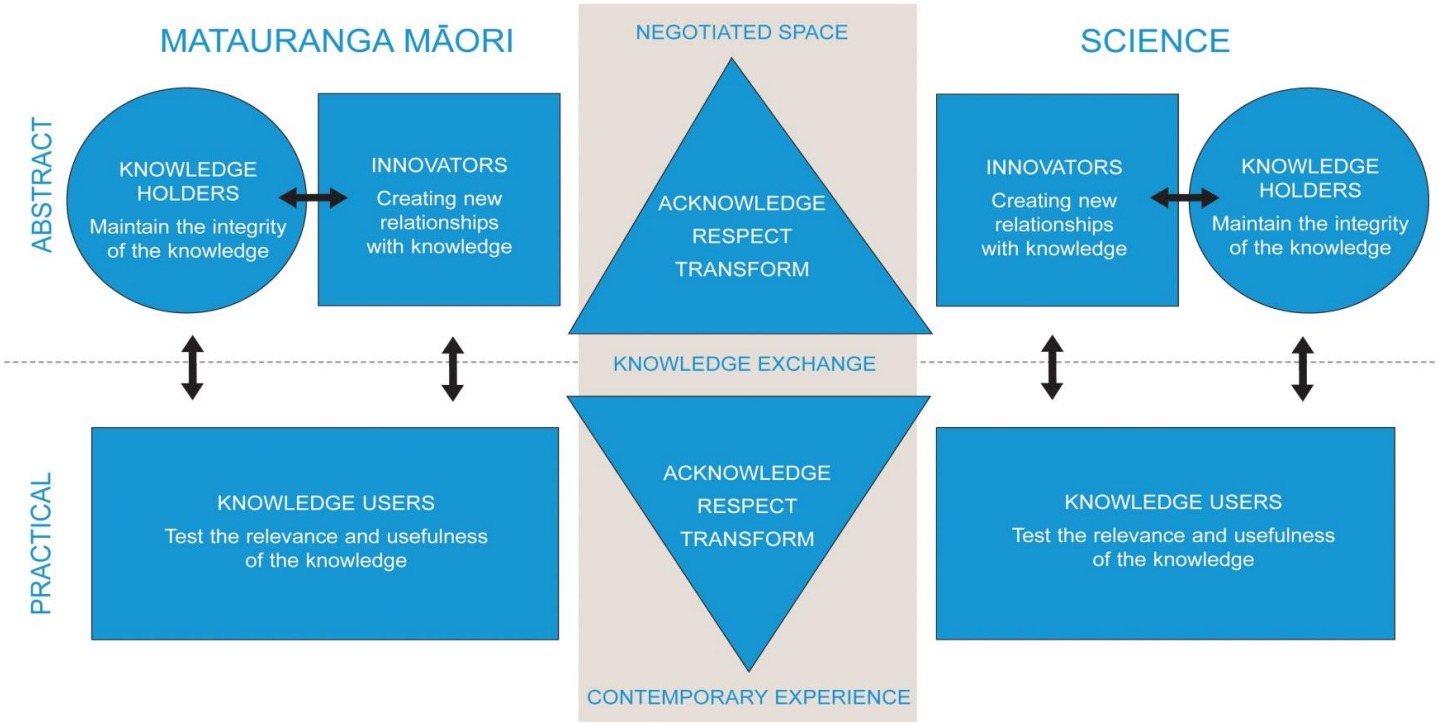
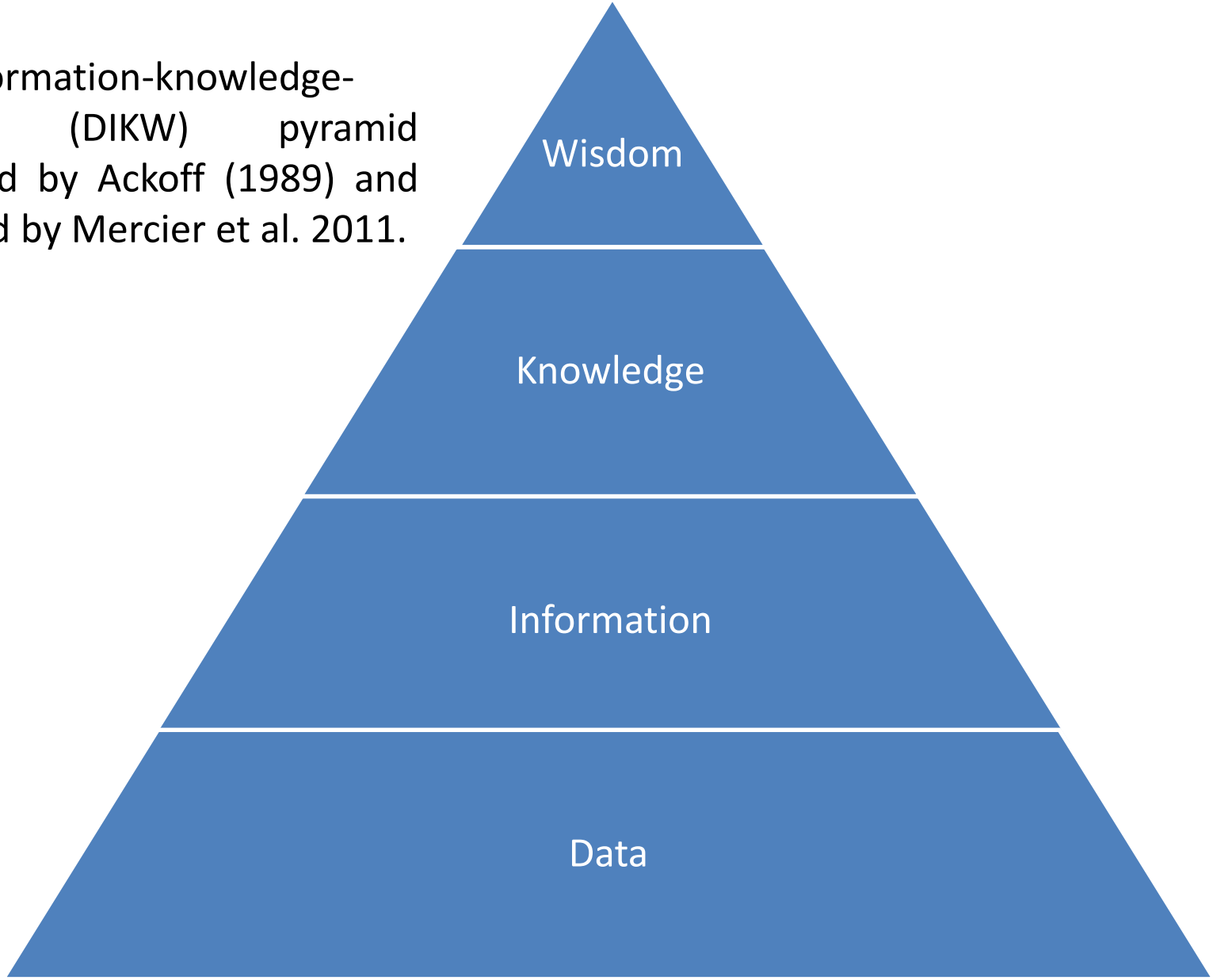
Interface of knowledges
Co-creation of knowledge
Co-design
Co-innovation

Integrated concept analysis – Bridging mātauranga Māori and science



Data-information-knowledge-wisdom (DIKW) pyramid suggested by Ackoff (1989) and discussed by Mercier et al. 2011.



(2) Ecosystem approaches – what are they? What do they tell us about integration? Whole systems?

Ecosystems

"An ecosystem is a community of living organisms (biota, micro-organisms, etc), interacting with non-living components (e.g., air, water, elements, minerals, soils), as part of a larger connected system".

Brings in notions of interaction, inter-dependency, inter-connections, integration", "functional parts", "structured systems"

Human beings, animals, microbes, and the environment

Ecosystems: Brings in the human element inter-connecting with the natural environment

Some scientists say that the entire planet/solar system is an ecosystem

Complex network or interconnected system – a network of interactions.

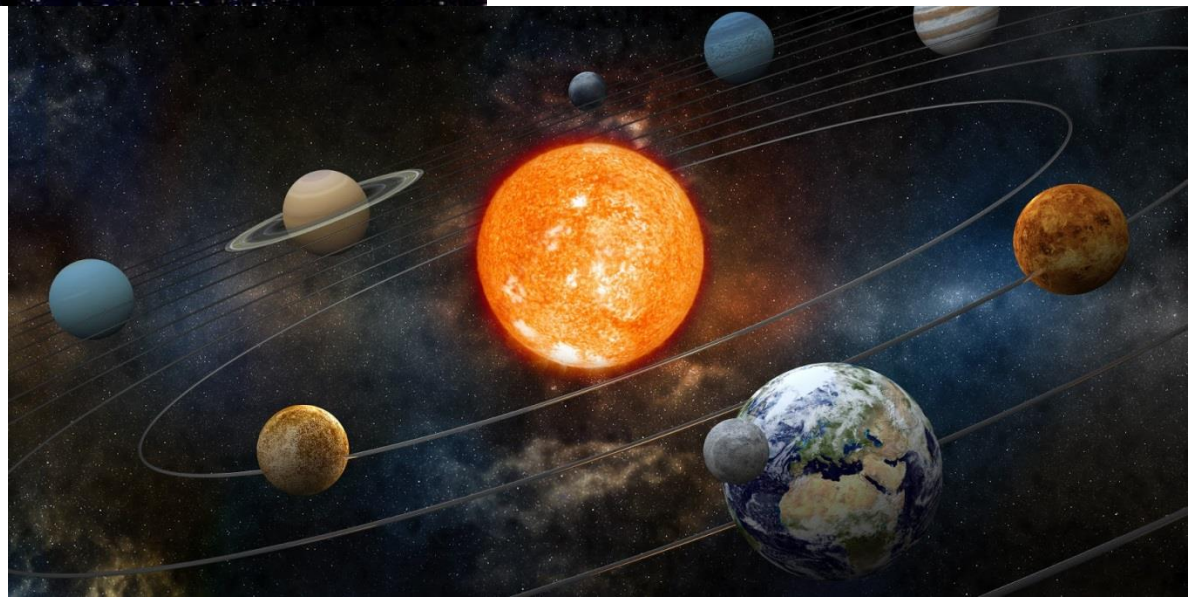
"Interacting organisms and their physical environment"

Linked biotic and abiotic components e.g., nutrient cycles, microbes, energy flows, etc. Between organisms and their environment.

Ecosystems, Habitats, Communities, Species, Viruses -
Bacteria -

Solar system – Energy

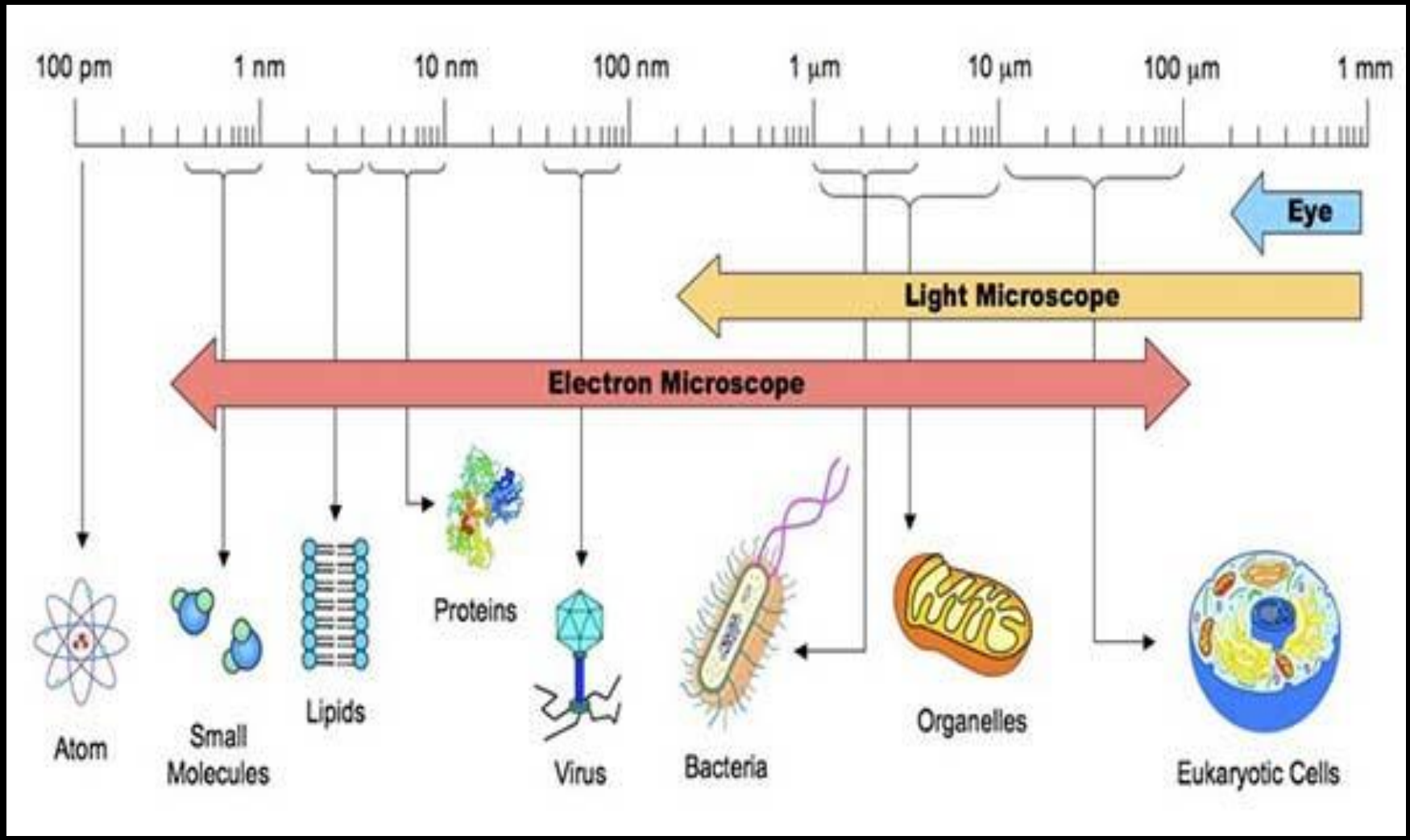
Solar system – **Energy is vital to all systems,** energy flows, light, heat, magnetism, radiation, gravitational forces, etc



Ecosystems and scale (adapted from Slocombe, 1993)

Physical scale (m)	Social	Economic	Biological	Physical
10^{-9}				Element (Angstroms 10^{-10}) Molecules
10^{-6}			Virus (20-400 nanometres)	
10^{-3}			Bacteria (0.2-10 microns)	
10^{-2}				
10^{0}	Individual Group	Corporation	Organism (mm, cm) Species	
10^{1}			Communities	
10^{2}			Habitats (M^2)	
10^{3}	City	Economy	**Ecosystem** Landscape (Km^2)	
10^{4}	Region			
10^{6}	Society Nation		Bioregion	Biosphere

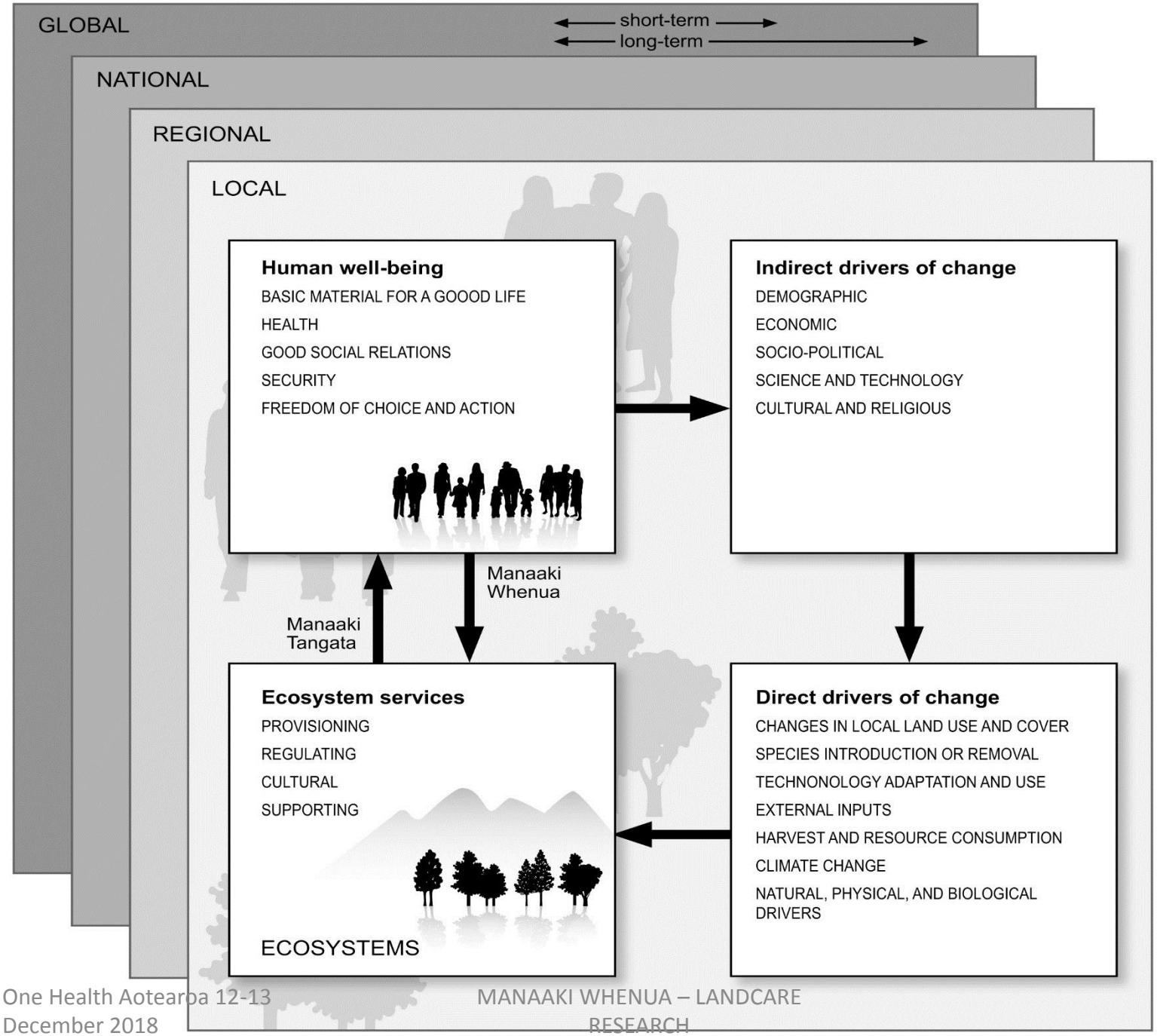
Scale-bacteria/viruses



Ecosystems: “The degradation of habitats as a by-product of resource exploitation has given rise to a growing body of literature which avers that ecosystem based management (EBM) is a prerequisite for sustainable resource management” (Curtina & Prellezo 2010, Kahui & Richards 2014)

Ecosystems: “The premise of this insight rests on the inter-connectedness and inter-dependency of ecosystem components emphasising the importance of underlying ecosystem structures (e.g., clean water, habitat) when exploiting a resource”(Curtina & Prellezo 2010, Kahui & Richards 2014)

“We’ve therefore seen a paradigm shift to holistic management” (Kahui & Richards 2014)


GLOBAL
short-term
long-term
NATIONAL
REGIONAL
LOCAL
Human well-being
BASIC MATERIAL FOR A GOOOD LIFE
HEALTH
GOOD SOCIAL RELATIONS
SECURITY
FREEDOM OF CHOICE AND ACTION
Indirect drivers of change
DEMOGRAPHIC
ECONOMIC
SOCIO-POLITICAL
SCIENCE AND TECHNOLOGY
CULTURAL AND RELIGIOUS
Manaaki Whenua
Manaaki Tangata
Ecosystem services
PROVISIONING
REGULATING
CULTURAL
SUPPORTING
ECOSYSTEMS
Direct drivers of change
CHANGES IN LOCAL LAND USE AND COVER
SPECIES INTRODUCTION OR REMOVAL
TECHNONOLOGY ADAPTATION AND USE
EXTERNAL INPUTS
HARVEST AND RESOURCE CONSUMPTION
CLIMATE CHANGE
NATURAL, PHYSICAL, AND BIOLOGICAL DRIVERS

(3) A Te Ao Māori perspective of ecosystems – holistic thinking

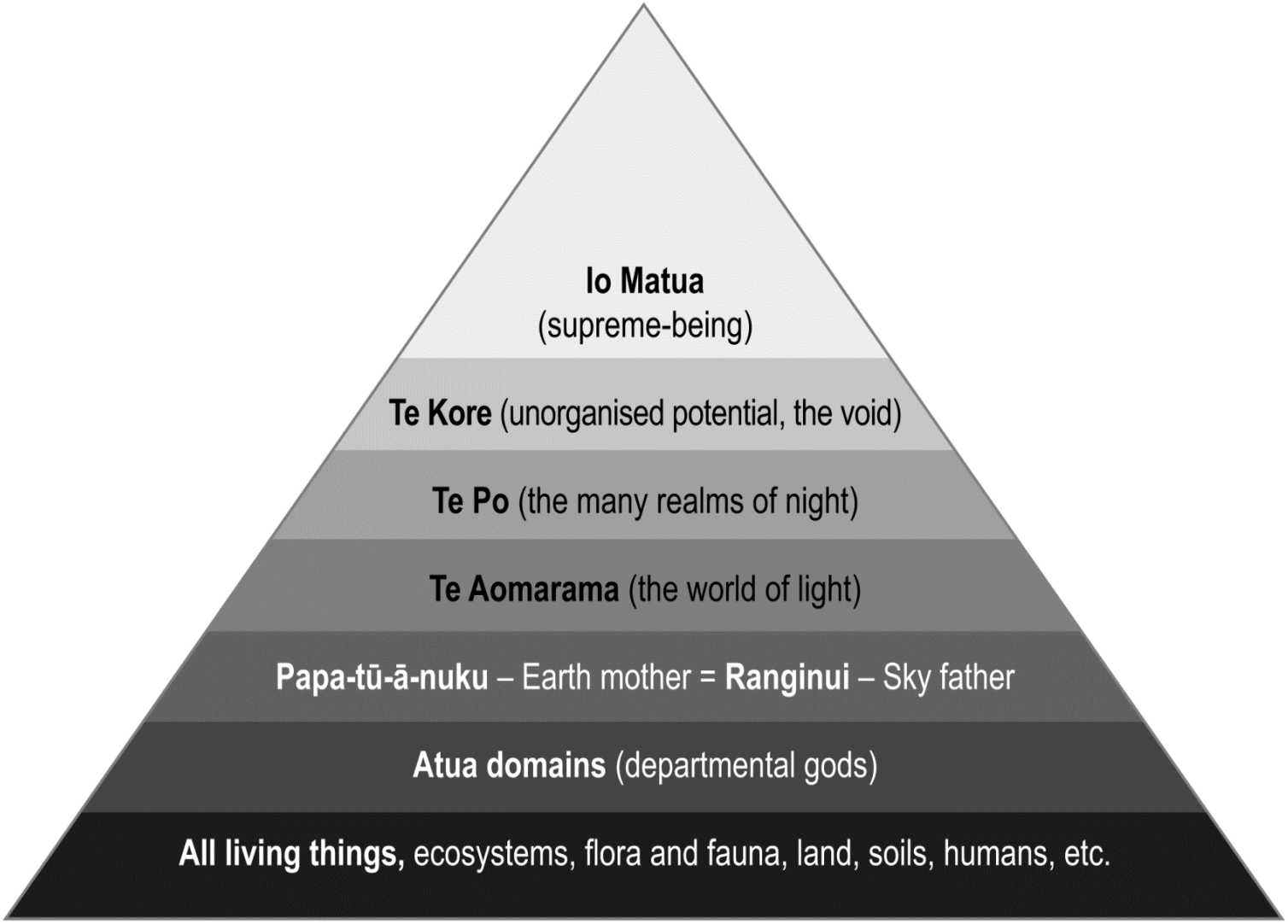
Ecosystems – a Māori perspective

No equivalent term in Māori

Māori perspectives are holistic and place human beings within the whole system, the ecosystem, ….and draw knowledge from creation stories, beliefs, using mātauranga Māori and Māori values, to provide knowledge, frameworks and concepts for understanding

Strong relationship between human wellbeing and environmental sustainability

Māori traditional beliefs – worldview



Atua domains

TWO PRIMEVAL PARENTS	
Papa-tū-ā-nuku – Earth mother = **Ranginui** – Sky father	
DEPARTMENTAL ATUA (CHILDREN)	
Tangaroa	The god of oceans, seas, rivers, lakes, and all life within them (and reptiles, fish, amphibians) & Tū-te-wehiwehi (grandson of Tangaroa and also referred to as the father of reptiles, lakes, rivers, freshwater)
Tāne-mahuta	The god of the forests and all living things within them
Tāwhiri-mātea	The god of winds and storms
Rongo-mā-Tāne	The god of cultivated foods (e.g., kūmara-sweet potato), also god of peace
Haumia-tiketike	The god of fern roots and other wild foods
Rūaumoko	The god of earthquakes and volcanoes
Tū-mata-uenga	The god of man and war
Whiro	The god of evil, the domain of darkness and death

Ecosystems – a Māori perspective

Best explanation and term that fits is probably:

Te Ao Marama – based on whakapapa, means a world of light and opening, symbolises a rich diversity of life, resources, and biodiversity and ‘richness of life’

Finding balance in the system – the principle of mauri

“Traditionally Māori acknowledged a natural order to the universe, a dynamic system built around the living and the non-living. Any shift in a system, for example through human interactions and/or impacts, cause shifts in the mauri of immediately related components. As a result, the whole system eventually becomes affected and degraded”. “All activities and relationships are bound up and governed by principles and ethics and regulated by an elaborate system of tikanga, ritenga or rules”.

The process is still used by Māori to guide resource use and management. Therefore, a key outcome for kaitiakitanga is to restore balance back the whole system, to maintain or restore the mauri, and to ensure this balance is maintained between people and the natural and spiritual worlds”.

Understanding core/intrinsic indigenous values – key cultural values/principles

Whakapapa (ancestry, lineage, rights)	Whanaungatanga (relationships, family connections)
Tikanga (custom, tradition, protocols, values)	Kotahitanga (unity, consensus, participation)
Rangatiratanga (sovereignty, empowerment, autonomy, management, decision-making)	Mana, mana whenua, mana moana, mana atua, mana whakahaere, mana tangata, whakamana, (based on whakapapa represents authority, power, control, status, leadership)
Manaakitanga (caring for, looking after, hosting)	Kaitiakitanga (environmental guardianship)
Tohungatanga (the retention and use of knowledge to benefit the tribe or business)	Tau utu utu (reciprocity, giving back what you take)
Wairuatanga (spiritual wellbeing, taking into consideration the spiritual dimension)	

External indigenous Maori values – location based/e.g., expressed in the landscape, lakes, rivers etc:

Wāhi tapu (sacred sites), e.g. urupā (burial grounds), sacred shrines (tuahu), wai whakaika (ritual or ceremonial sites), ana (caves)	**Wāhi taonga** (treasured sites), e.g. marae, kainga (settlements), pā (old fortified villages), forest
Wāhi tupuna (ancestral sites) – waka landing and anchorage sites (e.g. unga waka, tauranga waka), old battlegrounds, ara (tracks), rock outcrops, wāhi tohu (indicators) etc.	**Mahinga kai** – resource sites (traditional food source/collection areas), wāhi raranga – plant sources for weaving
Taonga: Flora and fauna, taonga species (**plants, trees, animals, birds, fish, etc**.), habitats (e.g. wetlands), rongoa (medicines), etc.	**Te Reo** – Place names
Landmarks: mountains, peaks, hills, lakes, rivers, coastal, geothermal areas, etc.	**Rock and mineral** source and trade areas (e.g. pounamu/nephrite/greenstone)
Important **archaeological sites**: artefact finds (e.g. adzes, carvings-whakairo, rock art, middens-ovens, waka/canoe remains etc.	**Metaphysical** (e.g. Taniwha), Atua domains

Values –Taonga spp.

Māori wellbeing and health

"Māori consider the environment fundamental to their well-being as their cultural values and the environment are inextricably linked. Finding a balance between the physical, spiritual, mental, and family dimensions of individuals was stated as the key to ensure optimum well-being".

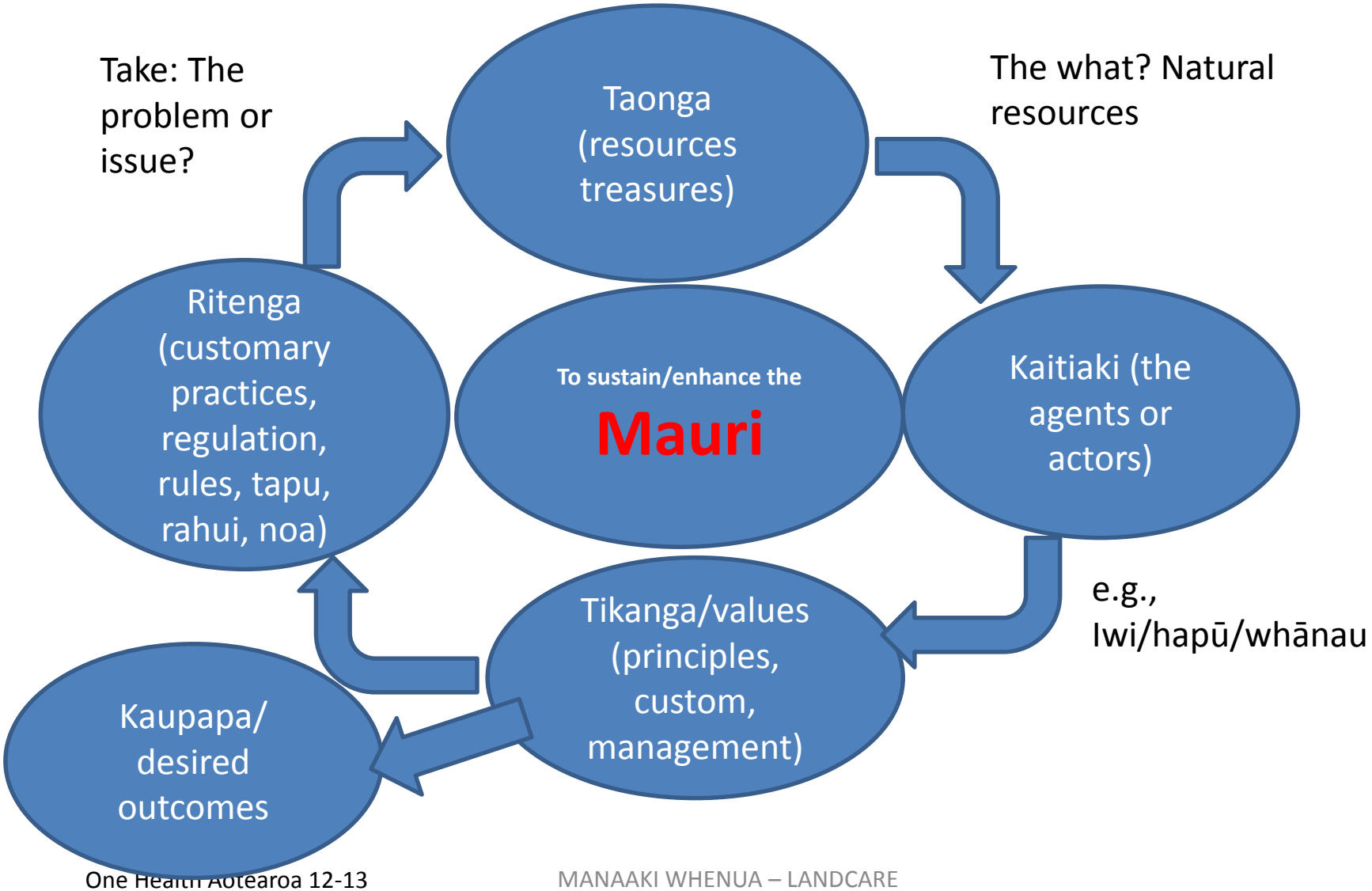
Key concepts: can be used to understand, manage, assess, monitor Māori values/resources

- Tikanga (customs)
- Mauri (life force, energy, spirit)
- Ora, oranga (wellbeing, health)
- Ritenga, tapu, rahui, noa (regulation and use)
- Classifications for water; e.g. waiora, waipuna, waimāori, waimate, waikino, waitakaro, waitai etc
- "Ki uta ki tai", "Ngā maunga ki te ngutu awa", Ngā maunga ki te moana" "ko te awa ko au" – Mountains to sea approach (whole catchment, big picture, holistic)
- Taonga tuku iho (precious, handed down through generations, inter-generational)
- Te Ao Tūroa (enduring, intergenerational, sustainability)

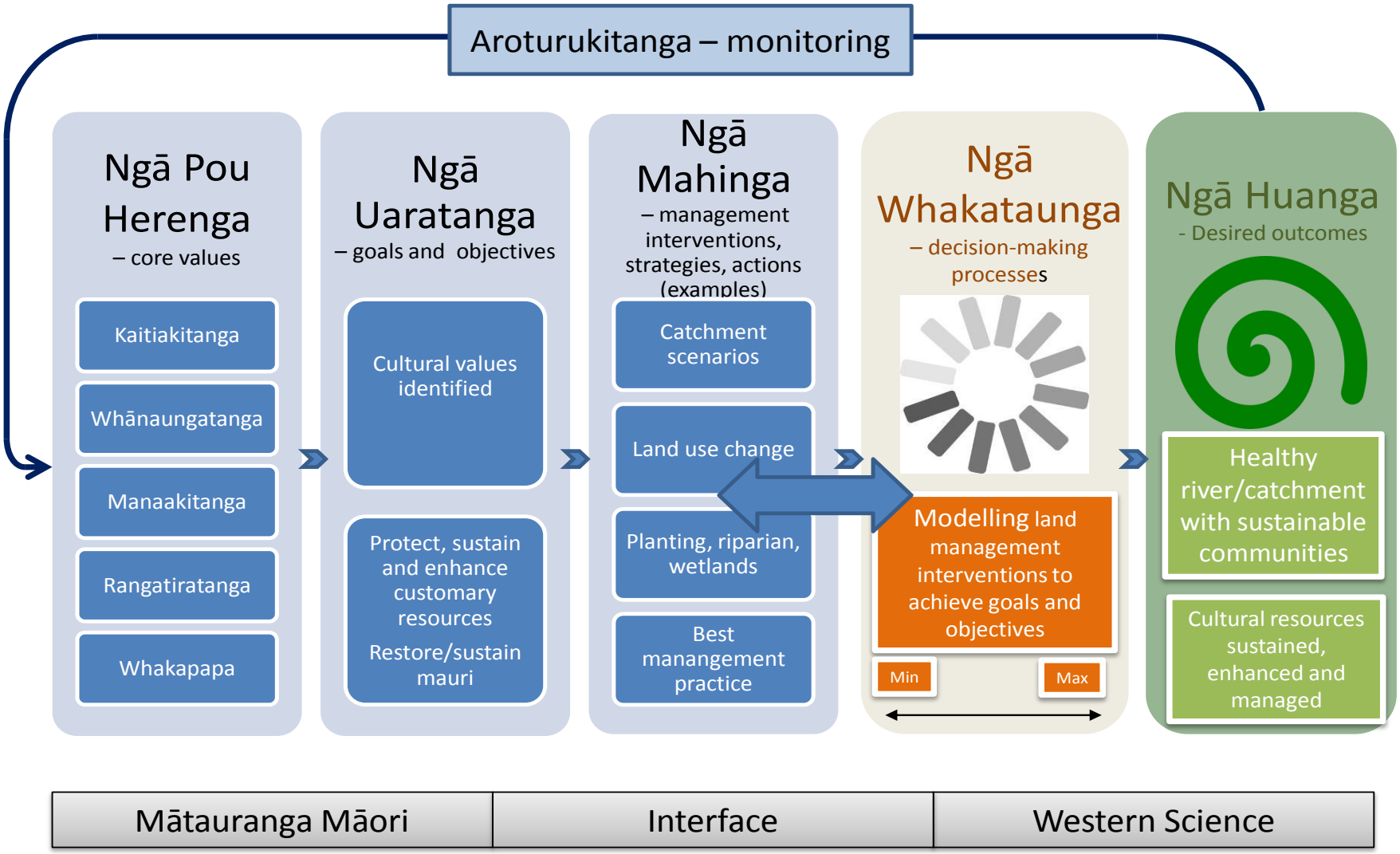
Taonga tuku iho

Te Ao Māori conceptual framework

(Hirini Matunga pers. comm)

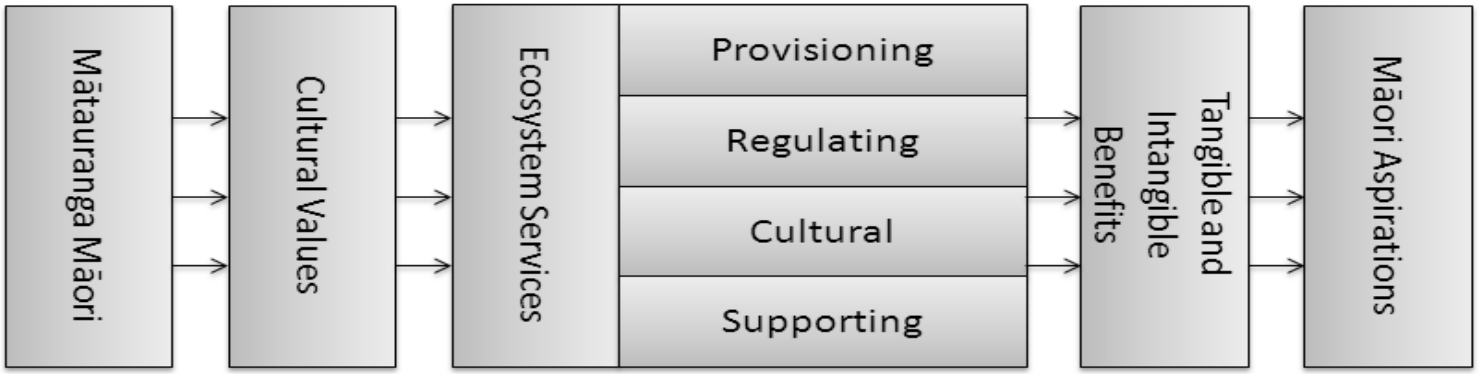


Mātauranga Māori and Modelling Interface



Aspirations, outcomes, goals

Ecosystem services and Māori values



Harmsworth GR, Awatere S 2013. Indigenous Māori knowledge and perspectives of ecosystems.

Māori objectives for freshwater include, for example,

- improved drinking water standards,
- goals and standards for water quality,
- sustaining or restoring the mauri of water resources,
- healthy waterways,
- protection and maintenance of cultural resources,
- connected and healthy communities, and participation in freshwater management.

- *Therefore a principal outcome for Māori, to achieve these stated objectives, is an active and inclusive role in the management of freshwater.*

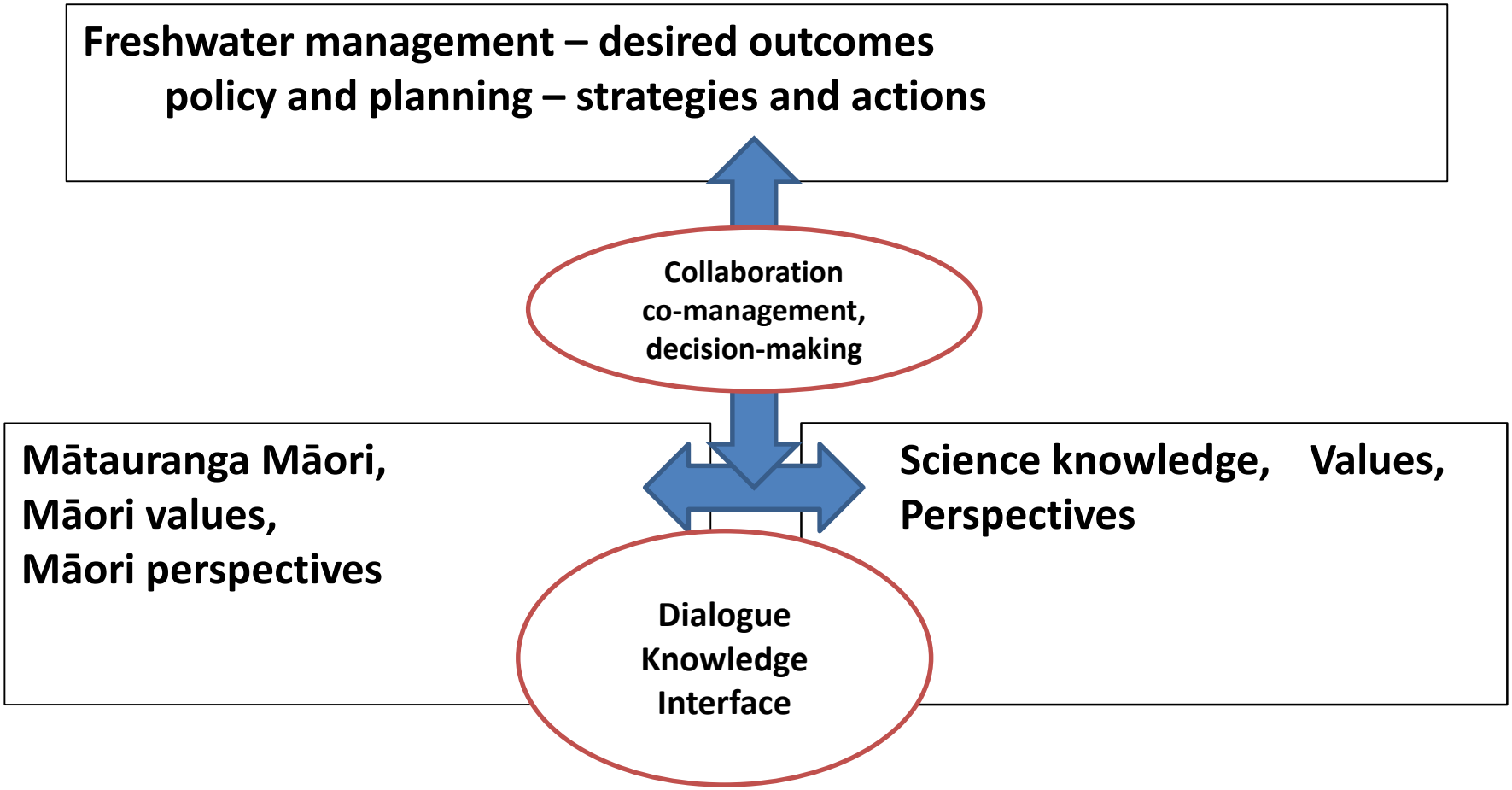


Figure 1: Dialogue space for understanding mātauranga Māori and science knowledge used to inform decision-making.

Rivers NPS-FM 2014

Attributes	Units	National bottom line
Periphyton (Trophic state)	mg chl-a/m^2 (milligrams chlorophyll-a per square metre)	Exceeded no more than 8% of samples -200 Exceeded no more than 17% of samples -200
Nitrate (Toxicity)	mg NO_3 -N/L (milligrams nitrate-nitrogen per litre)	6.9-Annual median 9.8-Annual 95th percentile
Ammonia toxicity **Based on pH8 and temp of 20°C**	mg NH_4 -N/L (milligrams ammoniacal-nitrogen per litre)	1.30-Annual median 2.20-Annual max
Dissolved oxygen (below point sources) **([1]Mean value of 7 consecutive daily minimum values)** **([2]And the lowest daily minimum across the whole summer period)**	mg/L (milligrams per litre)	7-day mean minimum[1] (Summer Period: 1 November to 30th April) – 5.0 1-day minimum[2] (Summer Period: 1 November to 30th April) -4.0
E coli	E. coli/100 mL (number of E. coli per hundred millilitres)	Numeric attribute state -1000
Lake fed rivers **Cyanobacteria -Planktonic**	80th percentile (12 samples/3 yrs): Biovolume - mm^3 /L (cubic millimetres per litre) OR Cell Count - cells/ mL (cells per millilitre)	1.8 mm^3 /L Biovolume equivalent of potentially toxic cyanobacteria OR 10 mm^3 /L total biovolume of all Cyanobacteria

Māori values NPS-FM 2017 (Te Mana o Te Wai)

WaiMāori, Waiwhakaika, Mahinga kai, Taonga tuku iho, Waitakaro, Waiputea, Waiara

Attributes/variables	Drinking water standards	Primary contact (e.g. swimming)	Secondary contact (e.g. boating, fishing)	Aesthetic, visual (no contact)
Microbial/Bacterial counts Viruses (no data available)	E coli less than one in 100mL of sample	<260 cfu/100ml (acceptable) 260-550/100ml 35 enterococci organisms/100mL (max 60-100 orgs/100mL)	Median 1000 faecal coliform organisms /100mL 230 enterococci organisms/100mL (max in any 1 sample 450-700)	
Protozoa	<1 infectious cyst per 100L of sample			
Natural clarity		Not >20% reduction Secchi disc >1.6m		
Turbidity NTU	2.5			
Periphyton	>8	>8	>8	>8
pH	7.0-8.0	6.0-9.0	5.0-8.0	5.0-9.0
Temp °C	<18	18-25	18-25	18-25
T Nitrate	50 mg/L (short term)	N = ug/L =10,000 Excellent <0.07 g N/m^3		Satisfactory: 0.07-0.44 g N/m^3
Nitrite	3 mg/L			
T Phosphorus		Excellent: <0.005 g P/m^3	Satisfactory: 0.005-0.01 g P/m^3	
Ammonia (as N)	Ammonia -1.5 mg/L	10		
Inorganic determinands of health significance (e.g. Arsenic, cadmium, mercury, etc) Toxic chemicals	Guidelines	Guidelines	Guidelines	Guidelines

Limits for Taonga spp									
Taonga	**Temp range °C**	**pH**	**T Nitrogen (ug/m³)**	**T Phosphorus (ug/m³)**	**Ammonia NH_3 g/m³**	**Sediment (sensitivity)**	**DO(30 day mean) (mgL^{-1}**	**Habitat loss**	**Catchment condition**	**Predators (vulnerability)**
Piharau (lamprey)	18-25	6.5-7.0	<0.7 <500	<20	Low-mod sensitivity	✓ (suspended)	>6.5 (>80%)	✓ v high	✓ (riparian, dams)	Humans
Tuna (eel)	22-25	6.5-7.0	<500	<20	Low-mod sensitivity	✓ (suspended)	>6.5 (>80%))	✓ v high	✓ (riparian, dams)	Humans
Toitoi (common bully)	20-22	8.7	<500	<20	High sensitivity	✓ not turbid	> 3mg/L ~6.0-9.0 (>80%)	✓ v high	✓	✓ (trout)
Kōaro	<13-20	7.6	<500	<20	High	✓ not turbid	8.0-9.0 (>80%)	✓v high	✓(loss of forest)	✓ (trout, smelt)
Banded kōkopu	12-18	6.5-7.0	<500	<20	High	✓ Most sensitive	8.0-9.0 (>80%)	✓ v high	✓	✓ (trout)
Giant kōkopu	11-15	6.0	<500	<20	High	✓ not turbid	8.0-9.0 (>80%)	✓ v high	✓(loss of forest, dams)	✓ (trout)
Shortjaw kōkopu	12-18	8.3	<500	<20	High	✓ not turbid	8.0-9.0 (>80%)	✓ v high	✓ (loss of forest, dams)	✓ (trout)
Inanga	17-20	9.5	<500	<20	Low-mod	✓ not turbid, 420 NTU	8.0-9.0 (>80%)	✓ v high	✓	✓ (trout)
Kōura	<16	7.0-7.5	<500	<20	V high sensitivity	✓ not turbid	8.0-9.0 (>80%)	✓ v high	✓	✓(trout, catfish, perch, etc.)
Smelt	15-17	8-9	<500	<20	High sensitivity	✓ not turbid	8.0-9.0 (90%)	✓ v high	✓	✓ (e.g trout)
Kākahi		7.0-7.5	<500	<20	High sensitivity	✓v high	8.0-9.0 (90%)	✓ v high	✓	✓(parasites)
Invertebrates		7.0-7.5	<500	<20	<0.6g/m³	✓ v high	8.0-9.0 (>80%))	✓ v high	✓	✓

General classification of water (relationship to tapu and noa)

Wai ora	Water in its purist form, e.g. rainwater
Wai puna	Spring water
Wai whakaika	Ritual waters, pools, ceremonial
Wai māori	Freshwater water, water for normal consumption
Wai mate	Water that has lost mauri, degraded, could be associated with death, may not be able to sustain life
Wai kino	Bad, associated with danger, such as fast flows, rapids
Wai tai	Seawater, saltwater, the surf or the tide

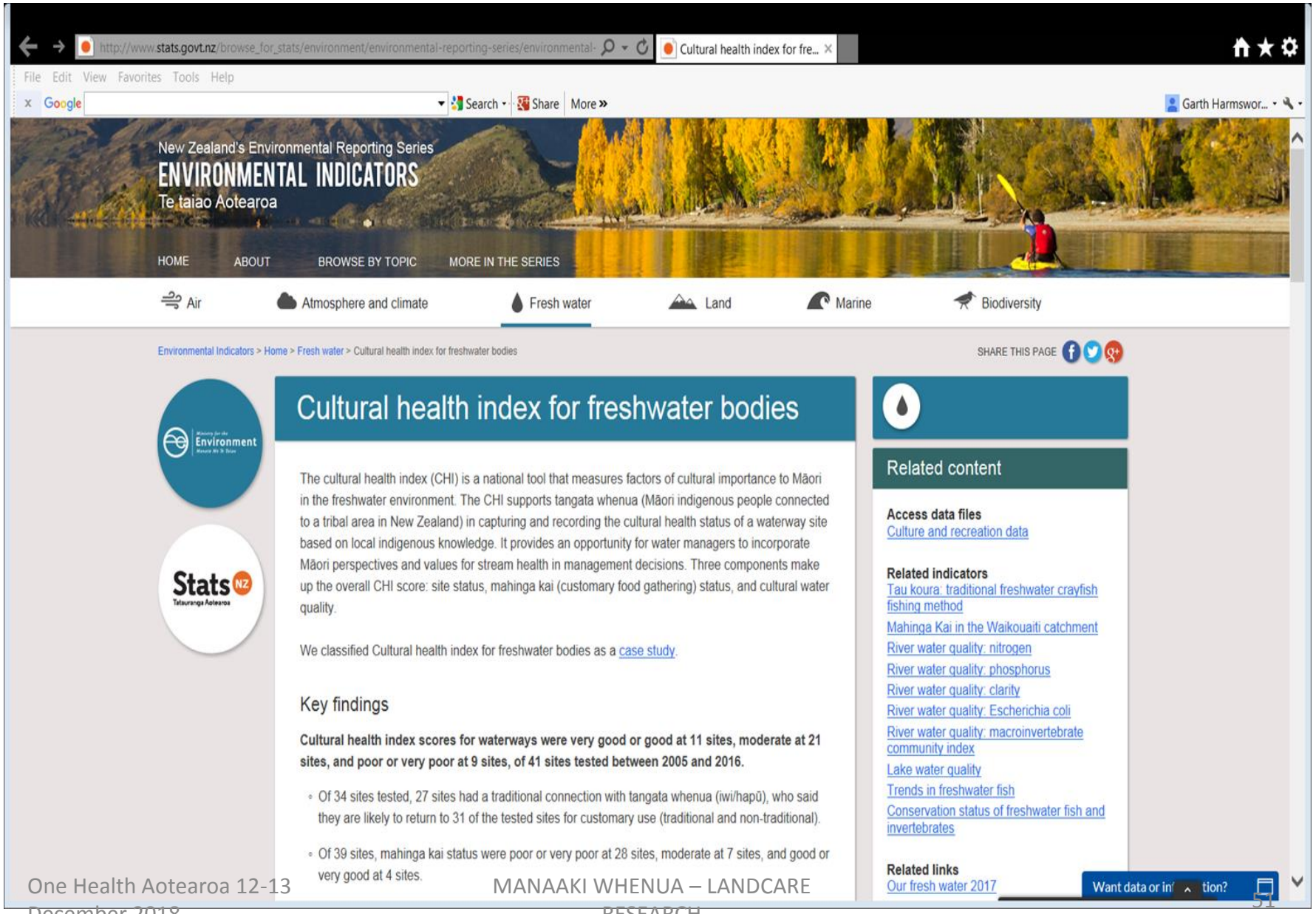
- **Taonga species monitoring and harvesting** e.g., tau kōura (e.g., Ian Kusabs), tuna (e.g., Caleb Royal, Erina Watene, Erica Williams, Ian Ruru, Mahuru Robb) etc.;
- **Cultural Health Index (CHI)** for Rivers and Streams (Gail Tipa)
- **Adaptation of the Cultural Health Index (CHI)** by Tiakina te Taiao for their own use and application Te Tau Ihu (Walker, Young et al. 2008);
- **CHI for estuarine environments** – Tiakina Te Taiao (Walker 2009);
- **State of Takiwā "toolbox"** iwi environmental monitoring and reporting tool Te Waipounamu/South Island – Ngai Tahu (Mattingley & Pauling 2005; Pauling et al. 2007; Te Rūnanga ō Ngāi Tahu 2007);

- **Cultural indicators of wetlands** (Harmsworth 2002);
- **The Mauri compass** (Ian Ruru 2012–);
- **The Mauri Assessment model** (Morgan 2011–);
- **Significance assessment method** for tangata whenua river values – Te Waipounamu/South Island (Tipa 2010)
- **Mauri of Waterways Kete and Framework** (Jefferies & Kennedy 2009)
- **Kaitiaki tools**: an internet-based Iwi Resource Management Planning Tool (NIWA website);
- **Ngā Waihotanga Iho: Iwi Estuarine Monitoring Toolkit** (Rickard & Swales 2009ab).

Existing cultural monitoring approaches for Aotearoa

Name of approach	Specific	Selected reference examples
Taonga (e.g., flora and fauna) species sampling, monitoring reporting, harvesting	Kōura (freshwater crayfish) Tuna (eel) Freshwater mussels; Kanakana/pihirau-Lamprey; Native fish species such as galaxiids spp., e.g., inanga, kōkopu, koaro, Plants such as kuta, raupō, harakeke, etc	Kusabs et al. 2015,a,b Williams et al. 2014 Rainforth 2008; Te Ao Marama Incorporated & Waikawa Whānau 2010; Kitson et al. 2012. Morris et al. 2013 Kapa and Clarkson 2009
Cultural habitats	Mahinga kai, cultural harvest sites	Stewart et al. 2014; Maxwell and Penetito 2007
Contaminants	Risk, customary resources	Kaitiaki tools; Stewart et al. 2014.
Report cards	2016 Pilot Waikato River report card: methods and technical summary Framework and methods guided by river iwi	Williamson et al. 2016.
The Cultural Health Index (CHI) for rivers and streams	CHI method and application https://www.mfe.govt.nz/sites/default/files/chi-for-streams-and-waterways-feb06-full-colour.pdf The CHI has been used extensively by iwi/hapū groups in NZ to inform decisions, and knowledge to support the collaborative process adaptations of the CHI for freshwater and estuarine environments	Tipa 1999; Tipa & Teirney 2003, 2006a,b; Townsend et al. 2004; Pauling et al. 2007; Nelson & Tipa 2012; Tipa and Associates 2013. Tipa & Nelson, 2012. Walker 2009 – Tiakina Te Taiao; Young et al., 2002; Townsend et al., 2004; Taranaki District Council, 2007; Hughey & Taylor, 2009; Harmsworth et al., 2011.
Baselines	Cultural health assessment	Pauling et al 2005
Cultural flow	Cultural flow preference studies	Tipa 2009, 2012; Tipa & Associates, 2013; Tipa and Severne 2010; Tipa and Nelson 2012; Rainforth 2014
Historic data and information	Mapping of Māori values, historic places, cultural resources, etc.	Harmsworth 1997, 98; Tipa 2013

http://www.stats.govt.nz/browse_for_stats/environment/environmental-reporting-series/environmental-indicators/Home/Fresh%20water/cultural-health-index.aspx



Mauri assessment (waterway health) – freshwater

Attributes of mauri	How mauri can be enhanced/restored?
Water depth, minimum flow	Increase minimum flow, maintain flows
Mahinga kai quality and availability **Abundance/presence/scarcity of taonga species**	Improve habitat for taonga, species such as tuna, kokopu, koura, kuta, harakeke, etc
In-stream nutrients	Reduce nutrient load from point source discharge and diffuse pollution sources
Native fish species (abundance/presence/absence/scarcity)	Ensure in-stream water quality parameters/analytes – e.g., phosphorus, toxicity, nitrates – can support and sustain native species populations and desired condition
Natural flow and flow variability	Ensure water takes do not significantly alter river and stream flow levels and improve flow variability by reducing the length of time flows are at or near minimum flow
Health of waipuna (freshwater springs) and aquifer quantity and quality	Ensure groundwater abstraction is sustainable and mitigations are implemented to minimise nutrient leaching
Wetland health	Ensure water takes do not drop the water table too low as to adversely affect wetlands, retain and restore culturally significant wetlands
Inter-connections between awa and people (marae/whānau/hapū/iwi)	Strengthen and support connections between people and waterways through cultural activities such as: increase understanding of mātauranga Māori, cultural health monitoring, customary rights, customary activities, mahinga kai, and recreation

National freshwater standards – Mauri assessment of freshwater at 4 main reporting levels

A. Pai rawa atu, ka rawe (excellent): mauri enhanced or restored, and a full range of cultural values and practices exhibited and maintained

B. Ka pai (good): mauri maintained (ecosystem functioning well), and a wide range of cultural values and practices are expressed, supported, and maintained

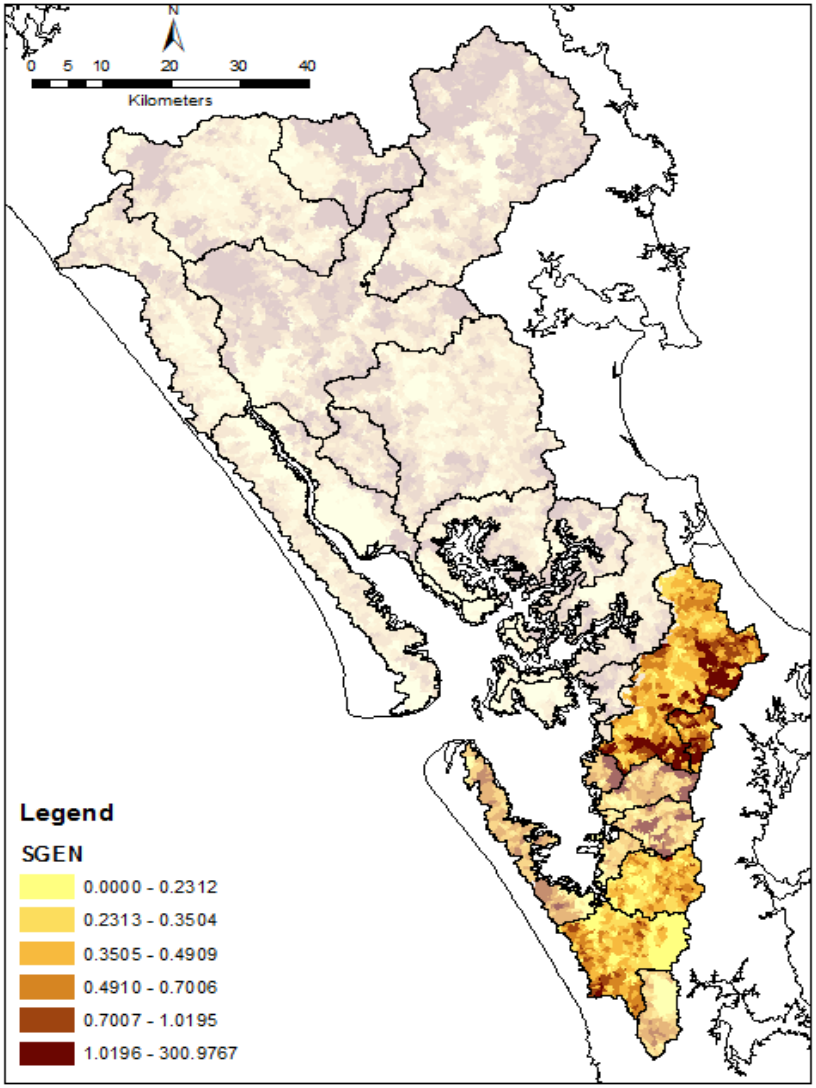
C. Āhua pai (fair): mauri below acceptable iwi/hapū standards and a paucity of cultural values and practices are expressed and maintained

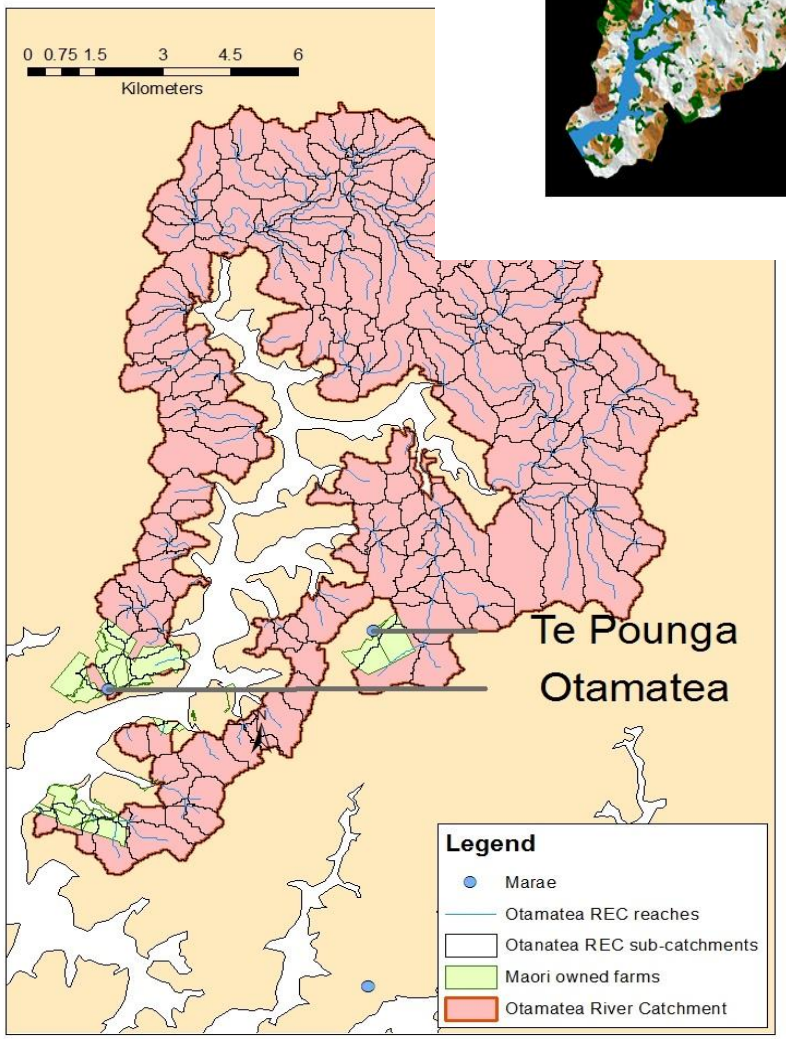
D. Kino, paru, pōhara (poor): mauri diminished/degraded and cultural values and practices not being sustained

Table. Links between values, objectives, monitoring, and actions to sustain or enhance the mauri

Values	Objectives	Performance measures/tools	Management variables (examples)
Kaitiakitanga Mauri Mahinga kai	Restore the mauri of freshwater to a standard Sustain/enhance cultural resources, mahinga kai, taonga spp. Define standards/limits/ above bottom lines *to support cultural values, life supporting capacity, ecological integrity, and ensure human wellbeing*	Monitoring such as CHI and mauri assessment identify change/trends in the state or mauri, or other indicators e.g. taonga spp. Condition of cultural resources, taonga spp., mahinga kai	Minimum flows Catchment management, Riparian, planting, landuse, erosion, Nutrient management/ reduction Water clarity & sed Pathogens (e.g., E coli) Stock exclusion Connectivity Habitat extent and condition

Kaipara catchment – Work with Te Uri o Hau



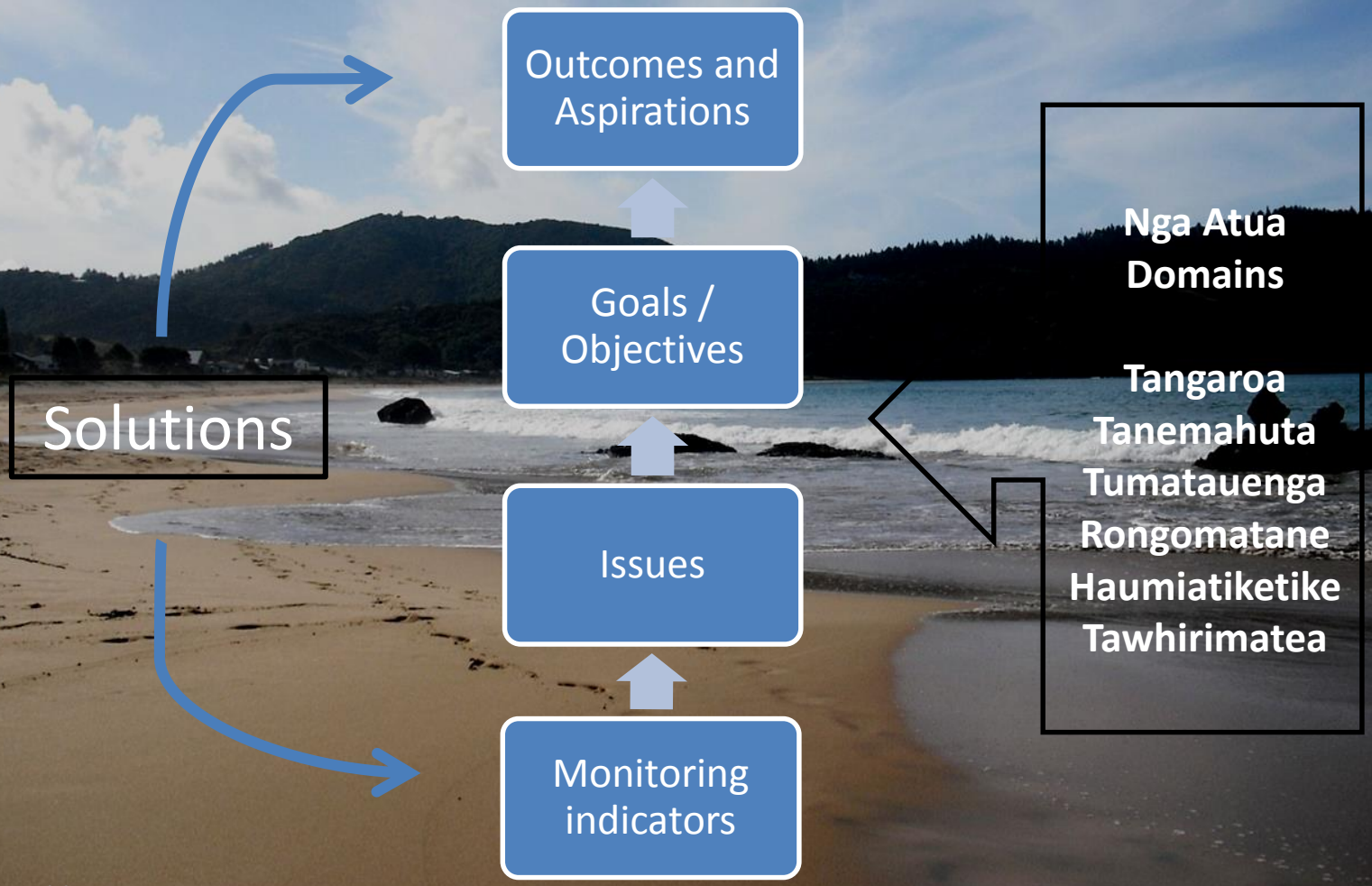


Kaipara harbour Integrated Kaipara Harbour management Group (IKHMG) and Te Uri o Hau

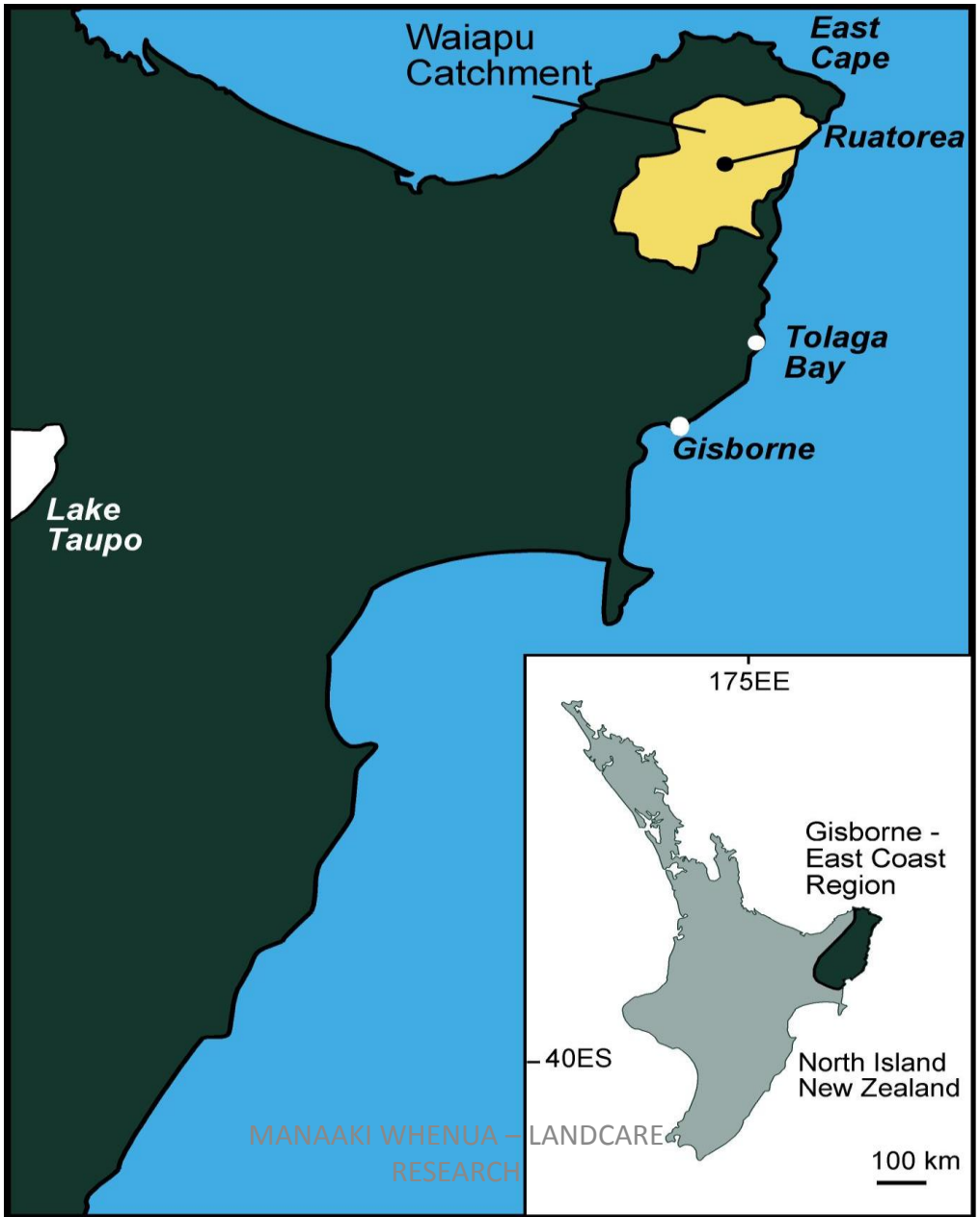
http://www.kaiparaharbour.net.nz/

http://www.uriohau.com/

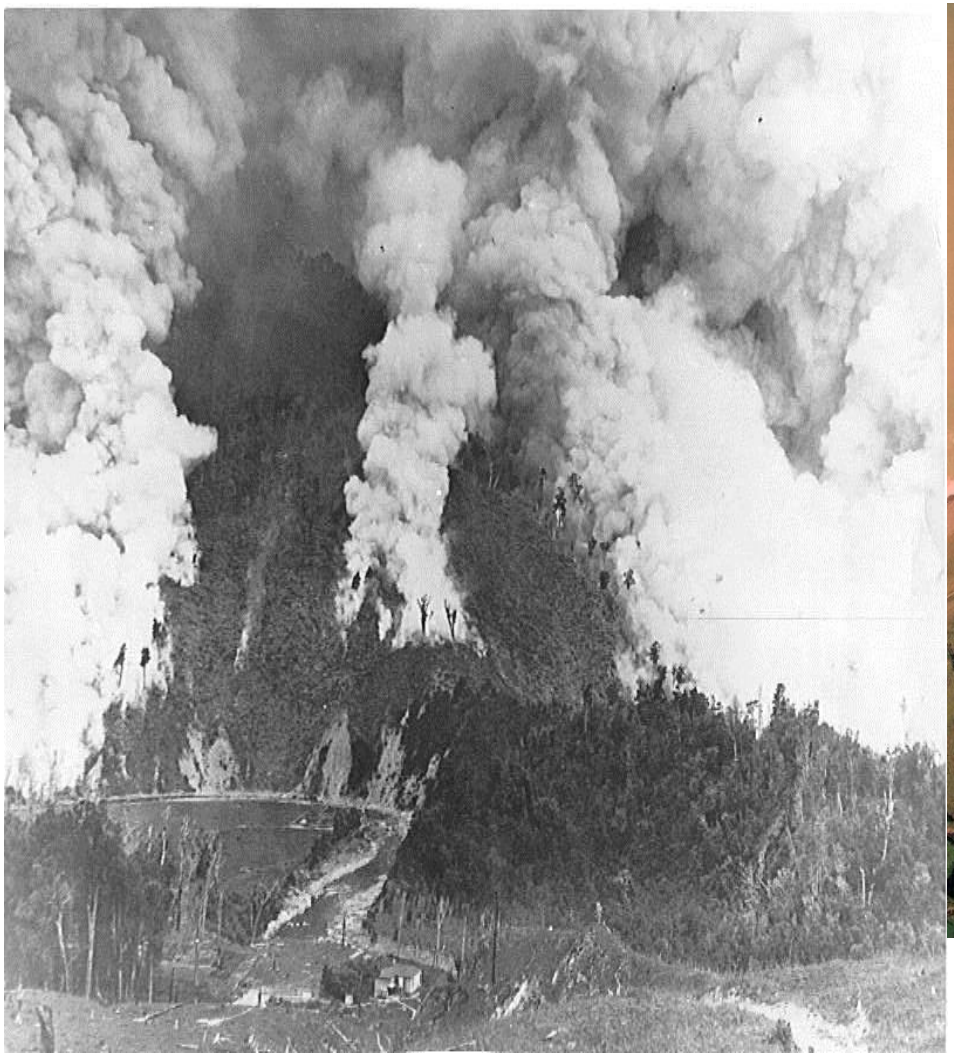
Te Uri o Hau Monitoring Framework



Monitoring on the Kaipara harbour – snapper catch

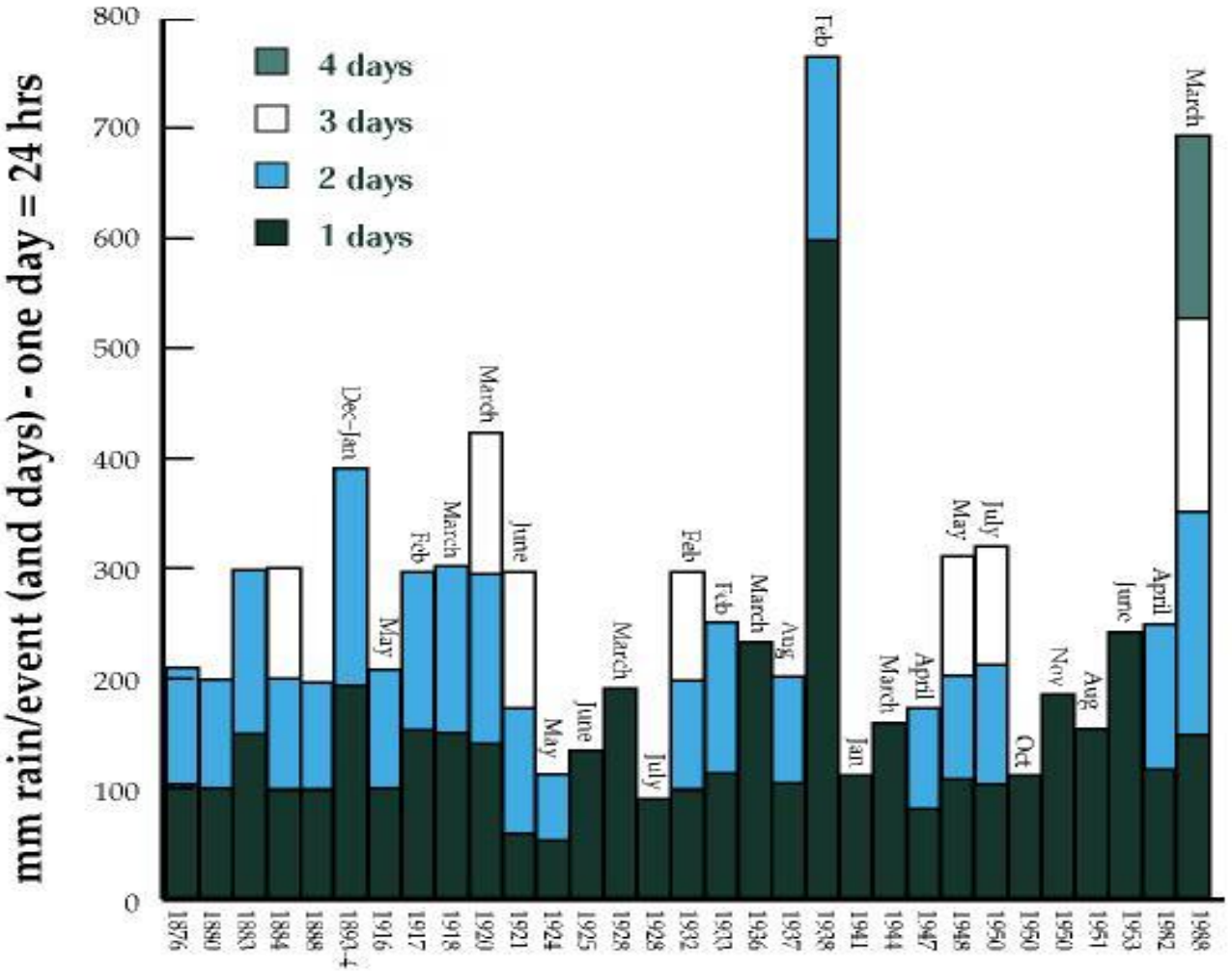

Waiapu
Catchment
East
Cape
Ruatorea
Tolaga
Bay
Gisborne
Lake
Taupo
175EE
Gisborne -
East Coast
Region
40ES
North Island
New Zealand
100 km

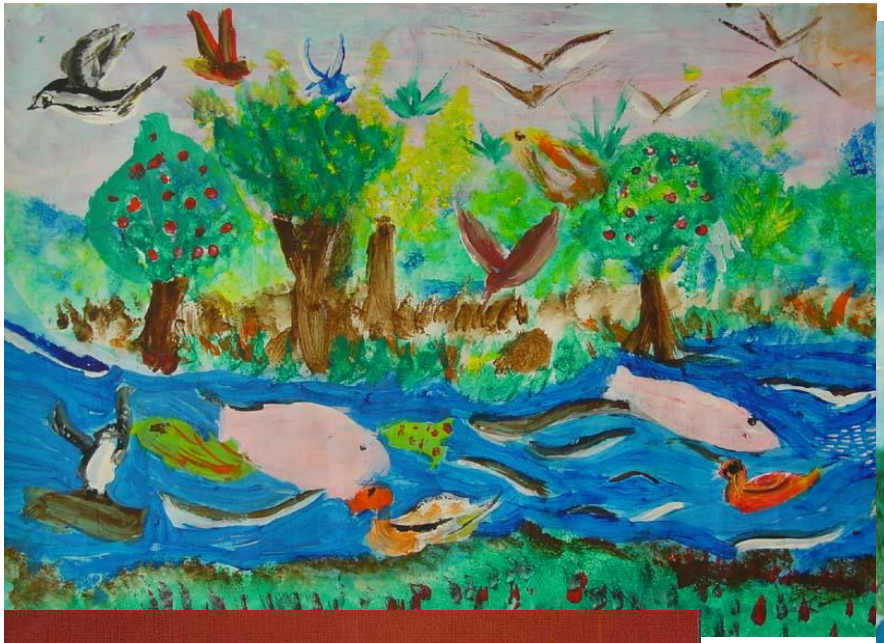
Large-scale deforestation of the Waiapu catchment, Gisborne East Coast, 1880-1930

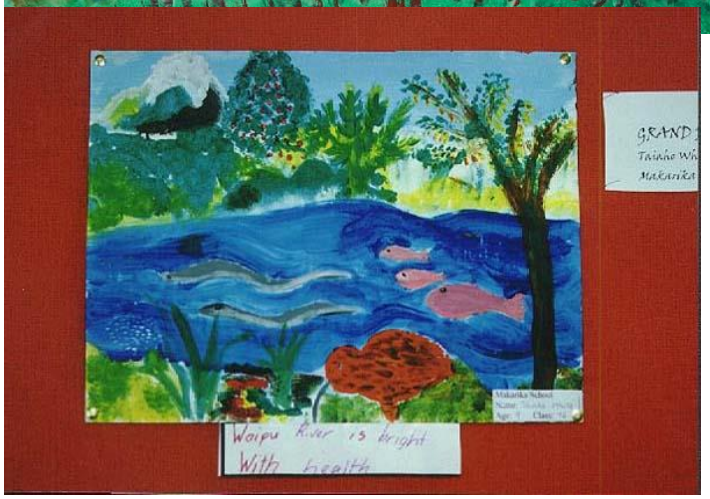


1990's – Large quantities of sediment from catchment to the coastal-marine environment

Major Storm and Flood Events (since 1876)

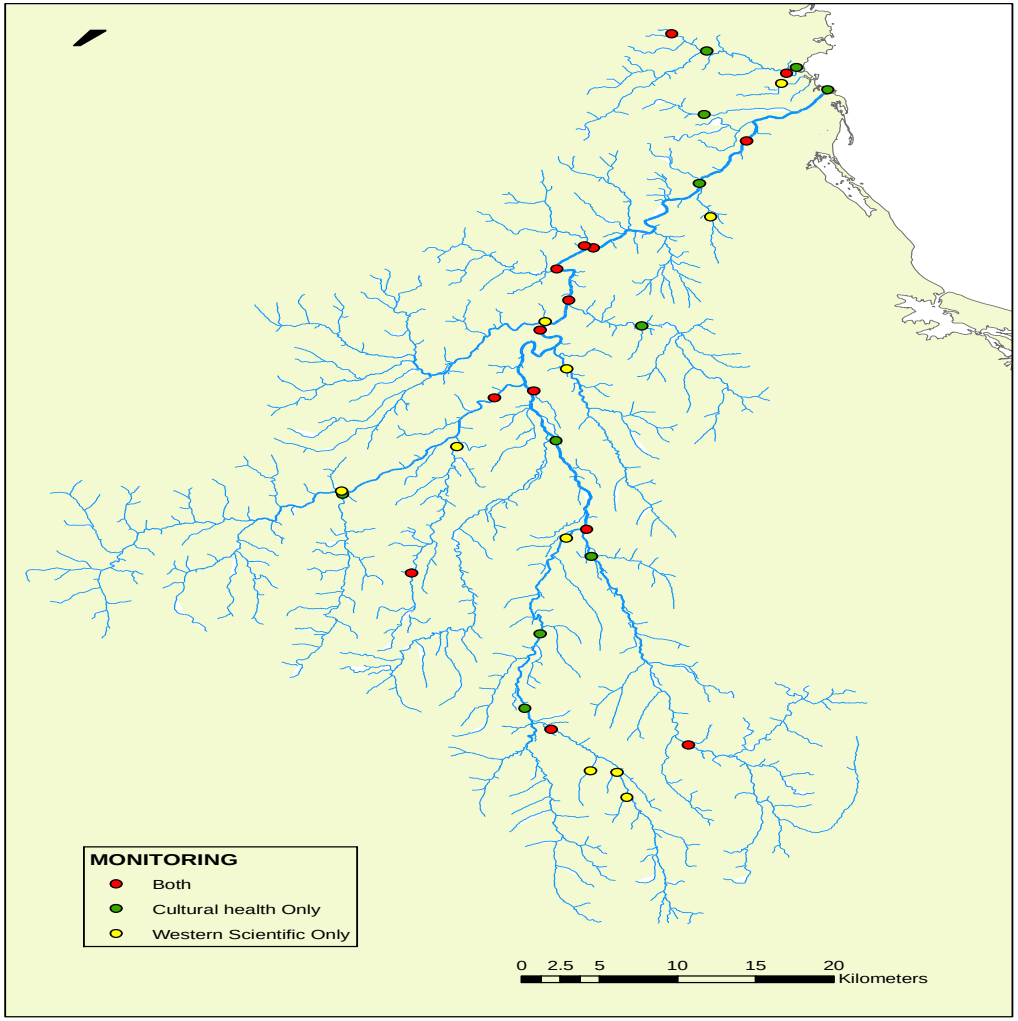






School art competition Ruatorea 2002:
What does a healthy environment look like?

Motueka and Riwaka catchments, north South Island



The iwi monitors in the field

Indicators (examples e.g., CHI)

Tangaroa

- Water Clarity
- Water Flow
- Water Quality
- Shape and form of river, riverbank condition, sediment
- Insects
- Fish

Tāne Mahuta

- Riparian vegetation
- Catchment vegetation
- Bird life (species)
- Ngahere/Taonga
- Pests

Haumia tiketike

- Mahinga kai
- Rongoa

Tūmatauenga

- Human activity, Use of river
- Access
- Cultural sites

Tāwhirimātea

- Smell

Mauri / Wairua

- Feeling, taste, wellbeing

Ngā Atua domains framework

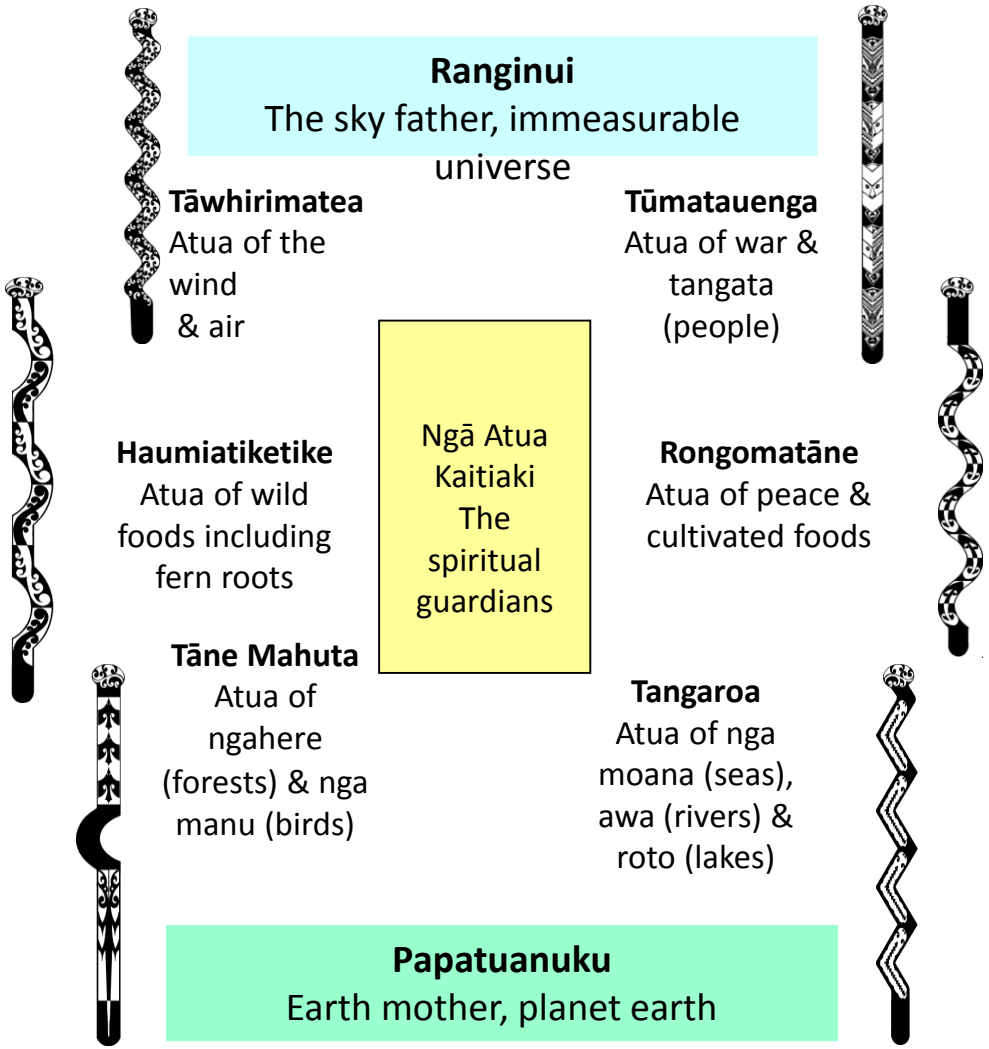


Figure 1: Atua (departmental gods) domain framework Source: Tiakina te Taiao.

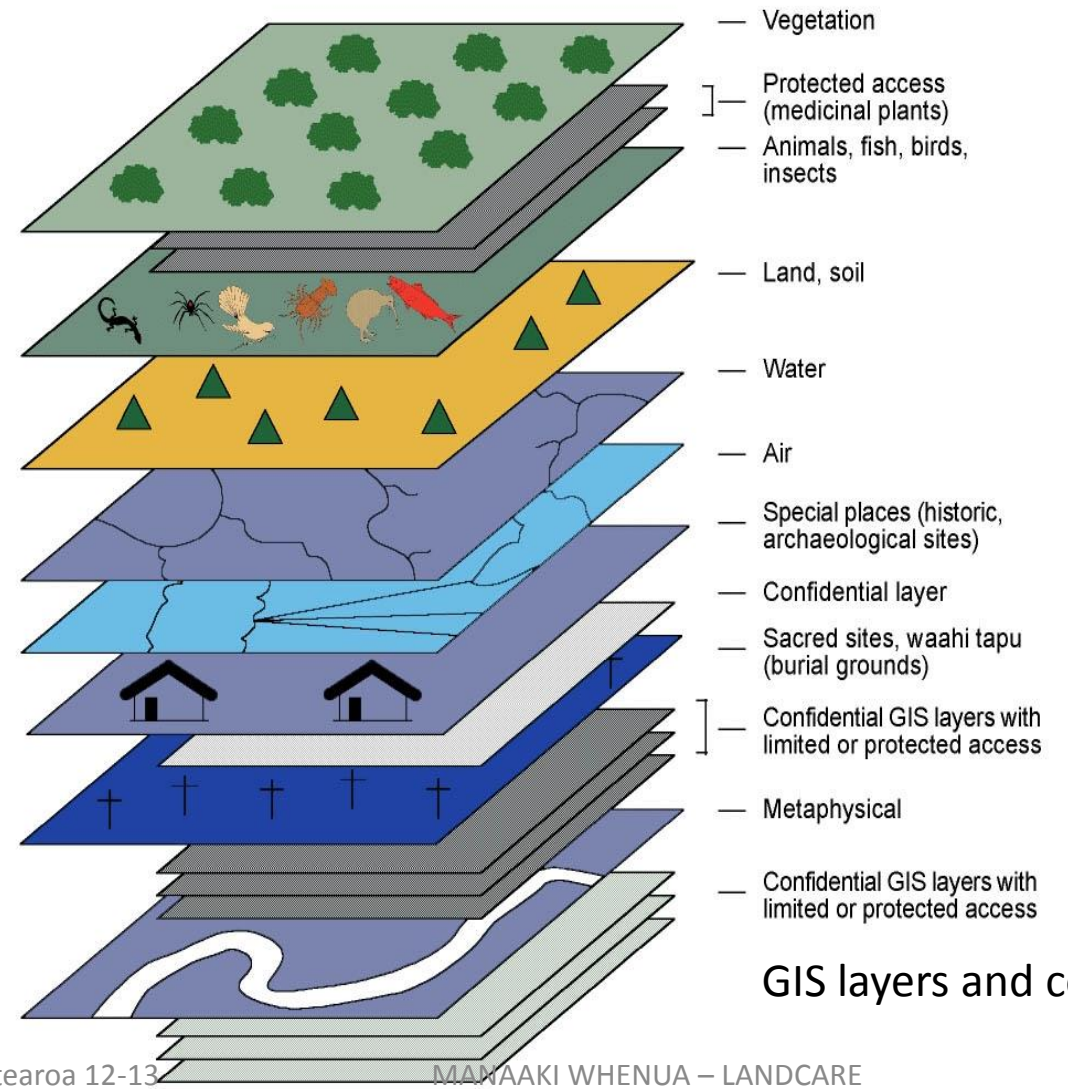
Indicator assessment and recording

Links between science and cultural indicators

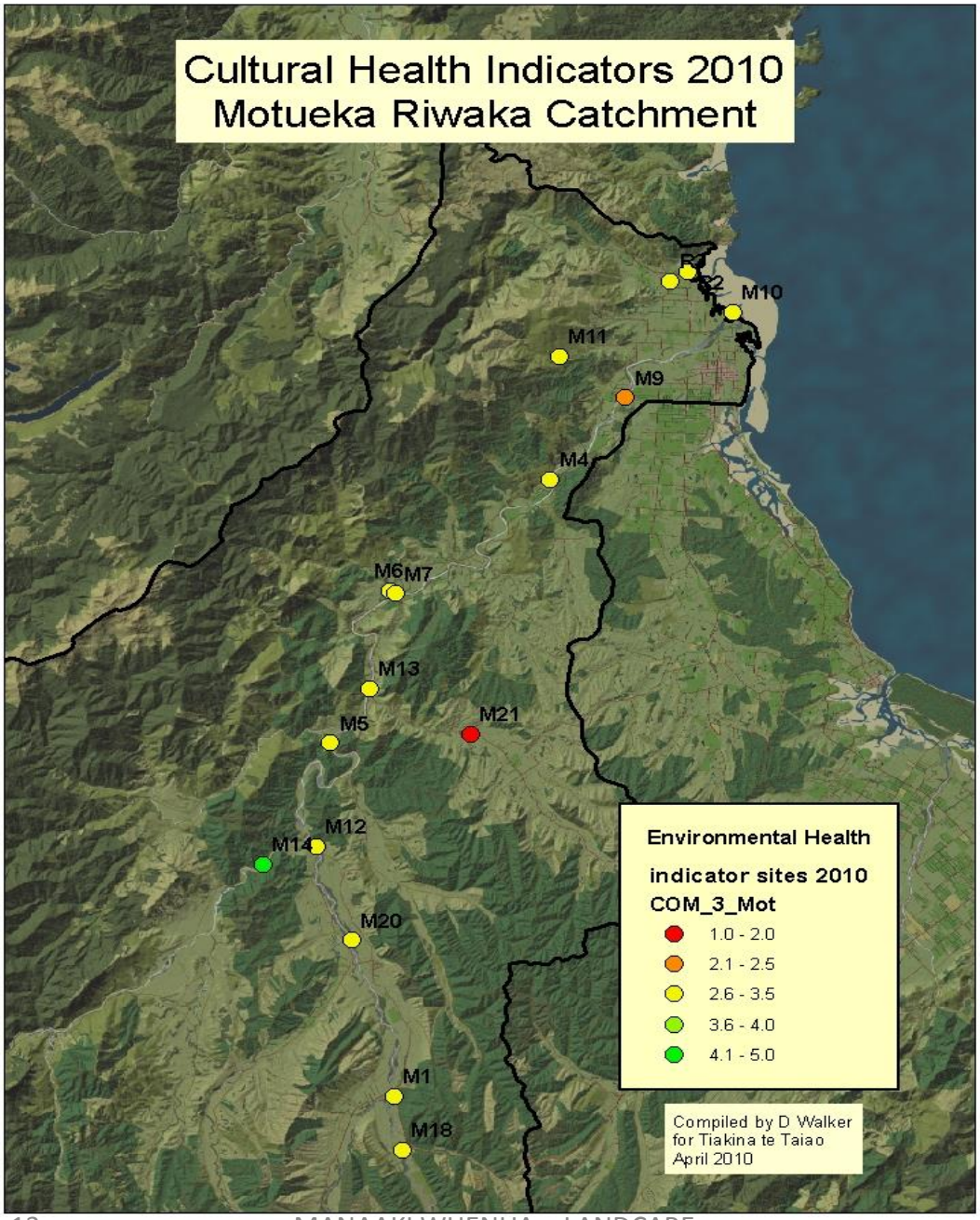
In future environmental monitoring programmes could be classed into three main types that are complementary:

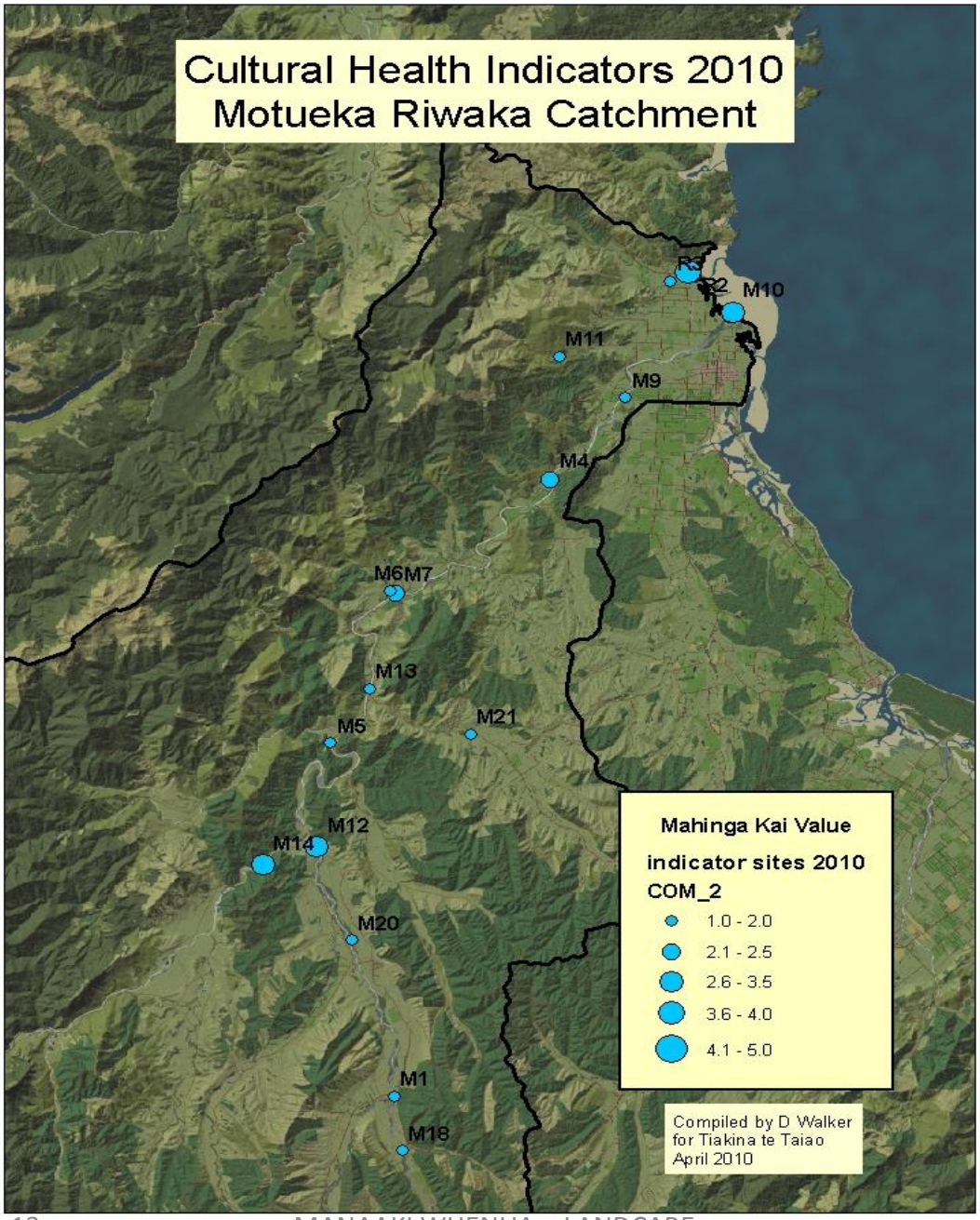
Māori knowledge based	Community – scientific based	Scientific based
Māori indicators – In depth Māori understanding and knowledge of particular environments. Understanding of Māori values, goals, and aspirations required. Examples: • Taonga lists; • Key sensitive taonga indicators; • Te Mauri/ wairua; • Knowledge on uses and preparation of taonga; • Land-uses, point discharges, modification, impacting on cultural values and uses. • Key pest species	**Community based indicators –** requiring low levels of technical input and skill but scientifically robust and part-value based. Cost effective, relatively simple and short duration. Examples: • Hydrology; • Soils/Nutrients; • Intactness of wetland; • Connectivity/Buffering or Fragmentation; • Introduced plants; • Animal damage; • Modifications to catchment hydrology; • Water quality within catchment; • Other landuse threats; • Key undesirable species; • % catchment in introduced vegetation; • Animal access.	**Scientific indicators –** requiring higher levels of technical input and skill, robust sampling strategies, analysis and interpretation. May be time consuming. Examples: • Chemistry, water quality, nutrients; • Hydrology; • Water table modelling; • Botanical mapping, classification of plants; • pH; • Bacterial counts; • Giardia; • Cryptosporidum; • GIS applications; • Satellite imagery; • Studies of fish, macro-invertebrates, macrophytes.

Layers of cultural and physical information in spatial and temporal information systems (Harmsworth (1999) Geographic Information Systems (GIS))



GIS layers and confidential sub-layers


Cultural Health Indicators 2010
Motueka Riwaka Catchment
M10
M11
M9
M4
M6
M7
M13
M21
M5
M12
M14
M20
M1
M18
Environmental Health
indicator sites 2010
COM_3_Mot
1.0 - 2.0
2.1 - 2.5
2.6 - 3.5
3.6 - 4.0
4.1 - 5.0
Compiled by D Walker
for Tiakina te Taiao
April 2010


Cultural Health Indicators 2010
Motueka Riwaka Catchment
M10
M11
M9
M4
M6M7
M13
M21
M5
M12
M14
M20
M1
M18
Mahinga Kai Value
indicator sites 2010
COM_2
1.0 - 2.0
2.1 - 2.5
2.6 - 3.5
3.6 - 4.0
4.1 - 5.0
Compiled by D Walker
for Tiakina te Taiao
April 2010

Goal: A generic set of mātauranga Māori based indicators for wetland condition and trend (Coordinated Monitoring of New Zealand Wetlands (1998-2003)

Maori terms for main wetland types

Level 1 Hydrosystem	Maori equivalent terminology
Estuarine	Wahapu /Hāpua/Muriwai
Palustrine	Repo
Marine	O Te Moana, a Tangaroa
Lacustrine	Roto, Moana
Riverine	Awa, Manga
Geothermal	Waiariki, Wai puia, Ngawha, Waiwera, Waipuna (springs)
Plutonic	Rarowhenua, Waipuna (Springs)

Wetlands

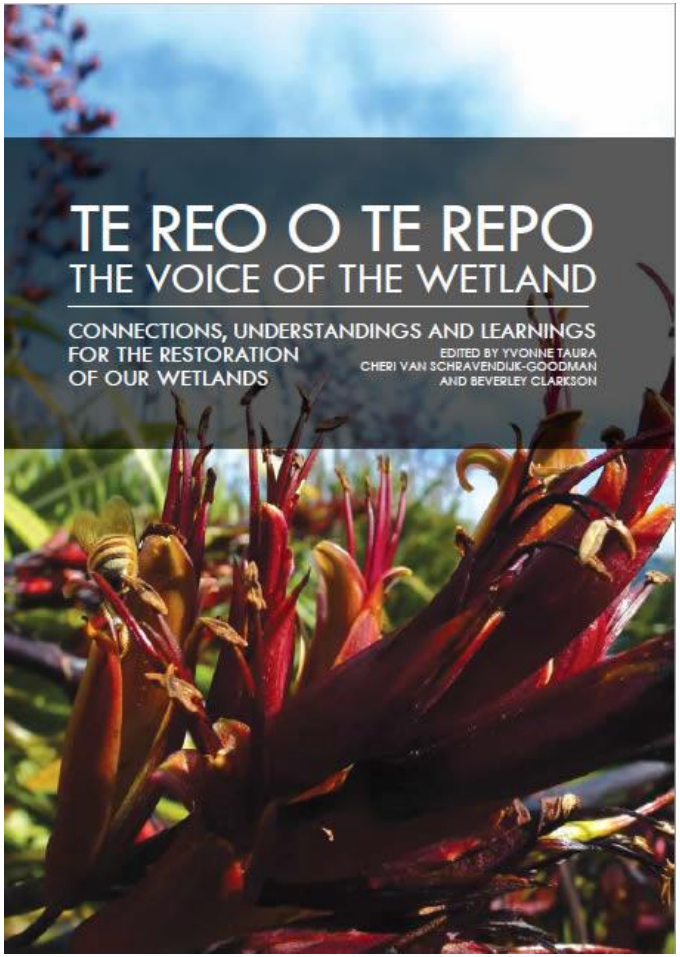
1. Māori wetlands handbook, Waikato-Tainui (Wetland Restoration Programme).

2. *Nga Tohu o te Taiao*: Sustaining and Enhancing Wai Maori and Mahinga Kai (UOWX1304)

Māori wetlands handbook

Te Reo o Te Repo – the Voice of the Wetland

http://www.landcareresearch.co.nz/publications/books/te-reo-o-te-repo



(4) Kaupapa

Working together – interdisciplinary and transdisciplinarity

Step 1: Entry into a geographic area

Building relationships and trust – starting the korero, agreeing on the kaupapa

Building Māori Capacity

Significant issues for Māori around water management – examples

- "Māori are increasingly keen to explore their **rights to freshwater**. These rights may exist as a consequence of custom and customary use, under the common law doctrine of aboriginal title, or under Article Two of the Treaty of Waitangi …"
- "The message that is coming consistently from Māori is that, to date, **the legal framework for managing water has not provided an adequate role for Māori".**
- **"Māori want a stronger voice in freshwater management and a role in decision-making as befits a Treaty partner."**
- "Māori can bring a unique contribution to freshwater management through the ethic of **kaitiakitanga**. The contribution that tangata whenua can make towards sustainably managing our water resources will be of benefit to all New Zealanders."
- **"Water is at the heart of Māori wellbeing"**

Comments after Pita Sharples speech on water at the National Iwi leaders summit (2009)

What are Māori objectives for freshwater and how do these align with those in Public Health?

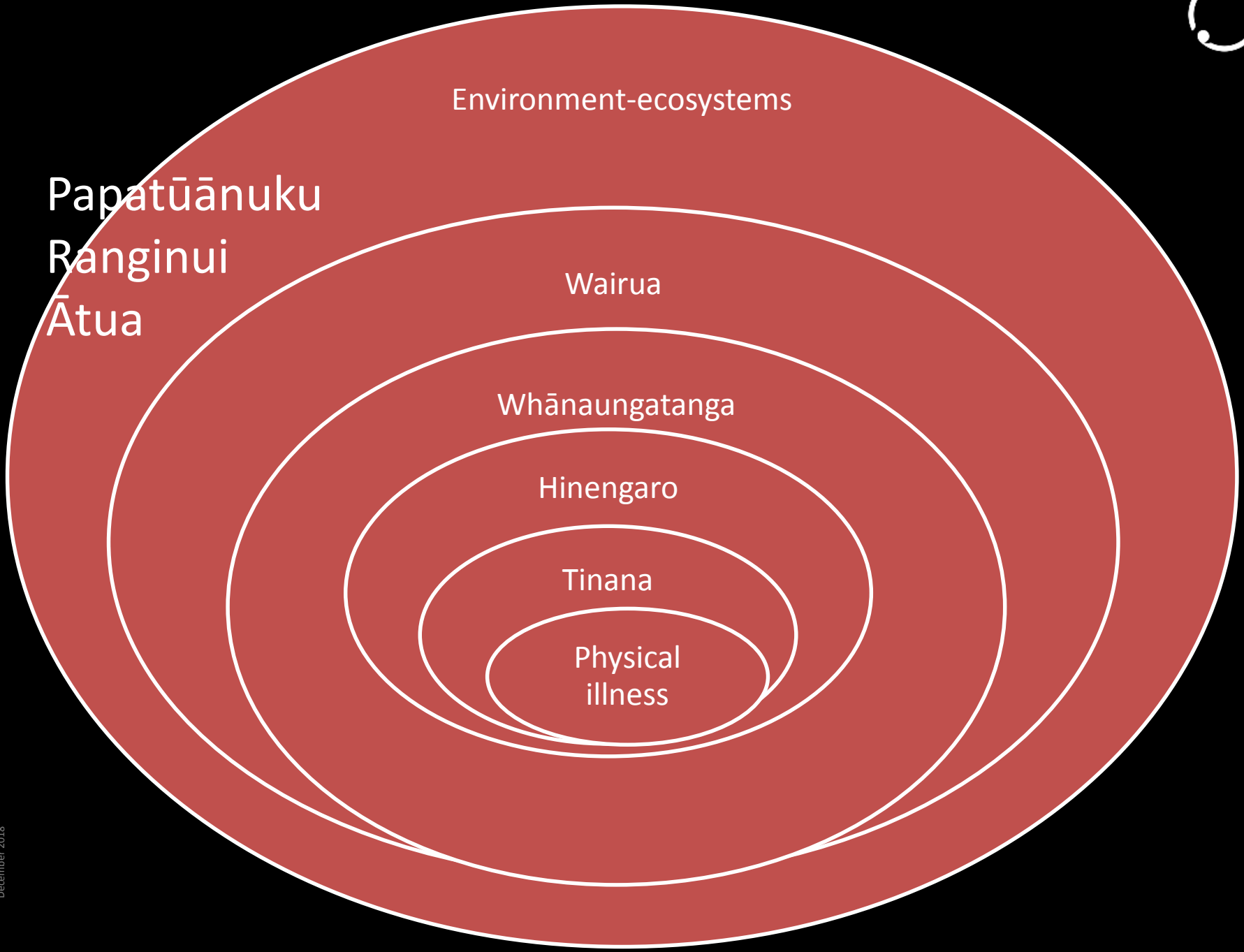
- *In the late 20th century many Māori believed the non-Māori health focus was too narrow and singular (i.e. concentrated too much on just physical illness) to meet their needs and did not reflect their traditional knowledge systems and values, and their holistic understanding of health and wellbeing.*
- *A number of kaupapa based holistic Māori conceptual health models were developed.*

Kaupapa based Māori health models

Models used to conceptualise the components of Māori well-being commonly emphasise the interactions and balance through 4 dimensions of reality:

- *taha tinana* – a material state or dimension, the body
- *taha hinengaro* – a mental state or dimension
- *taha wairua* – a spiritual state or dimension
- *taha whānaugatanga* – family, a related or associative state or dimension.

There are many variations of these models and concepts, but most stress a set of principles and practices to achieve a goal of mauri maintenance and human well-being (Durie 1994).


Papatūānuku
Ranginui
Ātua
Environment-ecosystems
Wairua
Whānaungatanga
Hinengaro
Tinana
Physical illness

Three common Māori well-being models (Durie 1994)

	Whare Tapa Wha	Te Wheke	Ngā Pou Mana
Components	Taha Wairua Taha Hinengaro Taha Tinana Taha Whānau	Wairuatanga Hinengaro Tinana Whanaungatanga Mana ake Mauri Hā a koro mā a kui mā Whatumanawa	Whānaungatanga Taonga tuku iho Te Ao tūroa Turangawaewae
Features	Spirituality Mental health Physical Family	Spirituality Mental health Physical Family Uniqueness Vitality Cultural heritage Emotions	Family Cultural heritage Environment Land base
Symbolism	A strong house	The octopus	Supporting structures

(5) Kaupapa

Complex multi-faceted challenges and issues in One Health.

Conclusions

We need new creative approaches to addressing –

Complex national and global issues and challenges (human and cultural behaviour often central) e.g.,

- sustainability, sustainable living
- antibiotic resistance
- infectious disease
- health hazards
- water quality
- climate change

Conclusions

A kaupapa Māori framework based on a mātauranga Māori/Māori values using a more holistic integrated methodological approach (e.g., environment, human health) can improve the way we conduct research with Māori (and non Māori) to achieve inclusiveness, incorporate different values, perspectives and knowledge, address critical issues, to achieve social equity and desired outcomes for all New Zealanders – especially to reduce inequalities (where Māori are over represented in some statistics (e.g. infectious disease) and under represented in others (e.g., decision-making, living standards).

Conclusions

One Health provides an opportunity and paradigm shift, to promote integration among disciplines and other knowledges, provide a place for understanding of holistic indigenous values and perspectives, for improved cross-sectoral collaboration, multi-, inter- and transdisciplinary research, knowledge and application …

To increase understanding, respect, integration, creativity and innovation in order to achieve outcomes

One Health

- Across knowledge systems;
- improved integration among disciplines; building bridges;
- Incorporate other perspectives and values to advance knowledge;
- Incorporate other values/perspectives to understand issues (e.g. infectious disease, ethics, gene modification, editing);
- Develop different method approaches (kaupapa Māori, interdisciplinary, transdisciplinary);
- improved cross-sectoral collaboration, multi-, inter- and transdisciplinary research, different perspectives;
- address complex national and global issues and challenges (e.g. antibiotic resistance, infectious disease, health hazards, water quality);
- pathways to better futures (equity, wellbeing, living standards)

Conclusions

1. Understanding different knowledge systems, beliefs, world views, provide broad perspectives and innovation within holistic and integrated frameworks e.g., Te Ao Māori and western science;
2. The concept of an ecosystem provides alignment with indigenous thinking of inter-dependencies, inter-connections of organisms, communities to find balance in whole systems and achieve wellbeing;
3. The next table provides conceptual examples of what this could look like. This type of framework can be used to explore synergies for Māori collaboration in One Health

Kaupapa Māori/mātauranga Māori	Science
Origin: Polynesian origin - ~5000yrs BP Make sense, comprehend and understand the world/universe/phenomena, find meaning and balance to life systems, develop technology, solve problems. **Principles** Underlying Māori values and principles Keep the object and subject conne values, religion, philosophy to guid knowledge collection/creation **Holistic, integrated, subjective** Often starts with the whole 'big picture', tries to find interconnections to validate the truth, to understand the whole and find a balance between the physical and spiritual worlds	**Origin:** Greek/Egyptian/Asian (~300BC) Enquiry – Find the truth, facts, understand phenomena. Comprehend/understand the world /universe, develop technology, solve problems. **Principles** Underlying science principles bject and the subject – remove myth, e, from the facts l organised enquiry to find the truth/ answers, using scientific method and process. **Objective/reductionist** Tends to be more reductionist, studies parts/components of a system in order to find answers because of complexity – requires integration to make sense of the whole and interconnections of system
Methods: Subjective, wānanga, hui, te reo, narratives, frameworks, concepts, observation, kaupapa Māori, experiment, observation, Knowledge 'handed down', systematic	**Methods:** Objective, hypothesis/prediction, theory, concepts, data, models, experiment, observation, repeatable, measurements, maths, universal laws, and verification, etc Knowledge documented/peer reviewed, systematic, organised

Interface of knowledges
Co-creation of knowledge
Co-design
Co-innovation

Making the connections in One health – based on different worldviews/knowledge

One health	Kaupapa Māori	Issue	Goals and Actions	Desired outcome
Improved integration among disciplines, engagement **Multi-disciplinary, inter-disciplinary** **Build bridges, collaborative research/strategies;** **Improve communication**	Working with Māori Effective collaboration based on Maori principles knowledge and understanding	Risk of infectious disease across all communities; Increase disease globally; global-migration; Increase disease outbreaks, epidemics, pandemics	Effective policy Maori and Pacifika understanding and awareness of infectious disease; Frame through Māori and Pacifika perspectives and issues; Improve health delivery, Improve housing, incomes, and living standards; Increase vaccination rates.	**Low infectious disease rates across all populations**
improved cross-sectoral collaboration, break down silos, use of other knowledge systems; **engage with policy;** **share knowledge and data;**	Holistic indigenous perspectives, build Māori capacity Transdisciplinary research Integrated knowledge systems used and understood	Poor water quality in Aotearoa-New Zealand; Degraded freshwater resources; Destruction of ecosystems, habitats and species	Build capacity Set cultural and environmental limits for water and resources Achieve drinking water standards in urban and rural	**Healthy water, water quality (e.g., swimmability) targets reached; standards/drinking water (potable) standards reached** **customary activities and resources (e.g., mahinga kai) maintained, mauri enhanced.**
Work across sectors, improved integration among disciplines; **improve communication**	Collaborative Māori research with One health researchers and professionals	Antimicrobial resistance, antibiotic resistance	Effective integrated policy and strategy Case studies	**Limit antibiotic use in wider population;** **Find substitutes for antibiotics**
improved integration among disciplines, knowledge and data sharing, communication	Collaborative Māori research with One health researchers and professionals	Intensive agriculture and urban expansion/human animal interface (e.g. *E coli*, campylobacter, pathogens, etc), high leaking nutrients, aquifers	Effective integrated policy; Improved planning to alleviate agricultural and urban impacts on health and environment	**Healthy landscapes, urban areas, catchment planning** **Reduce health hazards, Reduce animal disease**
Work across sectors , improved integration	Collaborative Māori research with One health researchers and professionals	Climate change, pests and disease, air quality, climate extremes, variability	Effective integrated policy Behavioural change	**Reduction in GHG emissions, healthy environments, low carbon economy**

Therefore

- One Health emphasises working together – collaboratively – within multidisciplinary, interdisciplinary and transdisciplinary teams;
- Broadening the knowledge base, creating new knowledge, understanding other values and perspectives to advance knowledge, and help address complex multi-faceted challenges and issues;
- Huge opportunities to improve research, planning and practice (e.g. method design, issues, principles, ethics);
- Build bridges to address many complex national and global issues and challenges (e.g. antibiotic resistance, infectious disease, health hazards, climate change, water quality).