Climate adaptation in the Torres Strait
Impact modelling

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Glossary

• System Drivers and Pressures (SDP)
  ➢ Human (Resource use, Land use, Pollution)
  ➢ Climate (Temperature, Rainfall, Sea level rise, Ocean acidification)

• Ecosystem assets / Habitats
  ➢ Coral Reefs
  ➢ Agricultural land
  ➢ Forest

• Ecosystem goods and services (EGS)
  ➢ Fish
  ➢ Oil palm
  ➢ Water

• Constituents of well-being (CoWBe)
  ➢ Health
  ➢ Income
  ➢ Food security
  ➢ Social cohesion
Impact modelling in Kimbe Bay

**Conceptual diagram**

Cross-scale comparison and evaluation

**Participatory planning and co-production of knowledge**

- Livelihoods
  - (Well-being)
- Drivers of change
  - (Climate and human)

Values

Adaptation

Sensitivity

Exposure

Production

Goods and services
- (EGS)

Ecosystem
- (EA)

Adaptive co-management

Outcomes
Impact modelling approach

System Drivers
- Human
- Climate

Act on

Ecosystem Assets
- Forest
- Biota
- Reefs
- Arable land

Which supply

Ecosystem Goods and Services
- Oil palm
- Water
- Fish
- Tourism

Which underpin

Constituents of Well-being
- Income
- Food security
- Health
- Social cohesion

Sensitivity and Exposure

EGS production

EGS values

EGS importance

Potential impact

Well-being impact
Impact modelling

1. Impacts to EGS from future Driver and Pressure scenarios
   - Change in EGS state
   - Future impact on livelihoods and well-being

2. Combine with community adaptive capacity to indicate Vulnerability
Approach

The approach is:
• semi-quantitative (relative scale where potential impact is assessed on a scale of 1 to -1)
• level of detail considered sufficient (note: always room for improvements)
• relies on expert opinion and local stakeholder review and modification

Limitations/simplifications to our study (can not consider all aspects)
Point out key assumptions
System Drivers and Pressures (SDP)

- “Business as usual” pressures

- Climate (Scenario A2, medium-high emissions)
  - Temperature, SST
  - Rainfall
  - Sea level rise
  - Acidification

- Human (Population growth - current trajectory)
  - Utilisation
  - Land use
  - Pollution

Assumption: climate and human impacts on habitats (e.g. seagrass/coral reefs) are implicitly accounted for the EGS (plan for this to be explicitly accounted for in future)
## Ecosystem goods and services

### Agricultural
- Banana
- Betel nut
- Cassava
- Chickens
- Coconut
- Garden vegetables
- Mangoes
- Pawpaw
- Pigs (domestic)
- Rice
- Sago
- Sweet potato
- Taro
- Yams

### Estuarine
- Barramundi
- Barramundi (aquaculture)
- Crabs (blue)
- Crabs (mud)
- Crocodiles
- Crocodiles (farmed)
- Finfish coastal (trevally, mullet etc)
- Mangrove timber

### Forest
- Birds
- Non-timber building material (palms)
- Pigs (wild)
- Rusa deer
- Rusa deer (farming)
- Timber for building/boats/sale
- Wallabies

### Freshwater
- Finfish (tilapia, snakehead)
- Prawn (Macrobrachyia)
- Saratoga
- Water (fresh and rainwater)
- Water (ground)

### Marine
- Dugong
- Finfish pelagic (queenfish)
- Mackerel
- Pearlshell (aquaculture)
- Pearlshell (goldlip)
- Prawn (banana, tiger)
- Rock lobster
- Sponge (aquaculture)
- Sponge (wild)
- Tourism (fishing)
- Turtles (flatback)
- Turtles (green)
- Turtles (hawksbill)

### Reef
- Beche-de-mer
- Clams (Tridacnid)
- Coral lime
- Other molluscs (and from mangrove)
- Reeffish
- Sharks and rays
- Tourism (reef)
- Trochus

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55 EGS in total
Sensitivity to stressors

Sensitivity scored on a scale from:

-1 (acutely negatively sensitive with no prospect for natural adaptation) to 

+1 (acutely positively sensitive and/or full adaptation capacity) to the threat

Accounts for factors such as tolerance thresholds (some marine species have acute thresholds e.g. corals and other species have a broader threshold e.g. crocodiles).

**Sensitivity:*** Degree to which an ecosystem asset is affected by or responsive to a driver/stressor.
## Consequences to change in stressors

<table>
<thead>
<tr>
<th>Stressor</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>In general, the productivity/growth rate of species increases with temperature, up to an optimal temperature, after which it declines with increasing temperature</td>
</tr>
<tr>
<td>SLR</td>
<td>Inundation interaction</td>
</tr>
<tr>
<td>Rainfall</td>
<td>Agriculture - probably decreased production with decreased rainfall</td>
</tr>
<tr>
<td>Acidification</td>
<td>Echinoderms and coral very sensitive (Impacts on calcifying species; calcification)</td>
</tr>
</tbody>
</table>

**Potential Impact** - cumulative impacts – summed across the multiple stressors (combining the possible positive with negative impact to give overall impact)
Exposure to stressors

Exposure was assessed against each asset on a scale from:
0 (no exposure/change in stressor)
to
1 (complete exposure/change in stressor).

Exposure scores were estimated at future time-step of 2030, 2060 and 2100.

Assumptions: Assessed the projected change in a 30km radius around each community.
Change from 2012 across the Torres Strait;

- Avg. surface temp. change
- Annual rainfall % change
- Avg. sea level rise (m)
- Aragonite saturation coefficient change

Projections about change stressor – used to determine exposure
Threshold – Critical level of population level

Population asset – may no longer provides a service before it is completely exploited (critical level of population level)

Assumption: consider both current population status for each EGS and population level when EGS no longer provides a service factoring this into the potential impact

Simple example to help with interpretation of potential impact/threshold:

<table>
<thead>
<tr>
<th>Species X</th>
<th>Current Pop. Status</th>
<th>Pop. level when EGS no longer provides a service</th>
<th>Cumulative potential impact at 2100</th>
<th>Projected pop. level given relative potential impact</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.80</td>
<td>0.20</td>
<td>-0.83</td>
<td>0.13</td>
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</tbody>
</table>

Threshold exceeded below critical level
Re-capping on variables

55 alternative assets (populations): List presented above

15 Communities in the Torres Strait: Badu, Boigu, Dauan, Erub, Hammond, Yam, Kubin, Mabuiag, Masig, Mer, Poruma, Saibai, St Paul, Ugar, and Warraber

7 stressors/pressures: Temperature, rainfall, Sea Level Rise, Acidification, Utilisation, Land use, Pollution

3 alternative time-steps: 2030, 2060 and 2100

• Whole of system
• Multiple impact
Warraber, Year 2030

Livelihood Importance (%)

- Finfish coastal (trevally, mullet etc)
- Reeffish
- Mackerel
- Turtles (green)
- Water (fresh surface and rainwater)
- Clams (Tridacnid)
- Trochus
- Dugong
- Cassava
- Crabs (blue)
- Non-timber building material (palms)

Potential Impact (-1 to 1)

- Temperature
- Rainfall
- Sea Level Rise
- Acidification
- Current patterns
- Wind
- Storms
- Exploitation
- Land use
- Pollution
- Trophic

Climate change

Human population growth
Badu, Year 2030

Livelihood Importance (%)

- Finfish coastal (trevally, mullet etc)
- Reeffish
- Water (ground)
- Rock lobster
- Mackerel
- Turtles (green)
- Water (fresh surface)
- Finfish pelagic (queenfish)
- Dugong
- Sharks and rays
- Garden vegetables
- Pigs (domestic)
- Crabs (mud)
- Cassava
- Pigs (wild)

Potential Impact (-1 to 1)

Climate change
- Temperature
- Rainfall
- Sea Level Rise
- Acidification

Human population growth
- Exploitation
- Land use
- Pollution
Saibai, Year 2030

Livelihood Importance (%)

- Finfish coastal (trevally, mullet etc)
- Reeffish
- Turtles (green)
- Water (fresh surface)
- Finfish pelagic (queenfish)
- Rock lobster
- Mackerel
- Crabs (mud)
- Sharks and rays
- Mangrove timber
- Prawn (banana, tiger)
- Barramundi
- Dugong
- Garden vegetables
- Crocodiles

Potential Impact (-1 to 1)

- Climate change
  - Temperature
  - Rainfall
  - Sea Level Rise
  - Acidification
- Human population growth
  - Exploitation
  - Land use
  - Pollution

Temperature: 
Rainfall: 
Sea Level Rise: 
Acidification: 
Exploitation: 
Land use: 
Pollution:
Dauan, Year 2030

Livelihood Importance (%)

- Finfish coastal (trevally, mullet etc)
- Finfish pelagic (queenfish)
- Reeffish
- Turtles (green)
- Water (fresh surface)
- Dugong
- Sharks and rays
- Garden vegetables
- Cassava
- Rock lobster
- Crabs (mud)
- Barramundi
- Non-timber building
- Crabs (blue)

Potential Impact (-1 to 1)

- Climate change
  - Temperature
  - Rainfall
  - Sea Level Rise
  - Acidification
- Human population growth
  - Exploitation
  - Land use
  - Pollution
Climate Vs Human Impacts

**Badu - Combined Livelihood Impacts**

- **Impact score (%):**
  - Climate
  - Human

- **Years:**
  - 2030
  - 2060
  - 2100

**Badu Impacts**

- **Climate change:**
  - Temperature
  - Rainfall
  - Sea Level Rise
  - Acidification
- **Human population growth:**
  - Exploitation
  - Land use
  - Pollution
  - Trophic

Impact modelling in Torres Strait
### Frequency of exceeded threshold – Critical level of population level

<table>
<thead>
<tr>
<th>Community</th>
<th>2030</th>
<th>2060</th>
<th>2100</th>
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</thead>
<tbody>
<tr>
<td>Badu</td>
<td>0</td>
<td>0</td>
<td>3; Turtles (flatback, green and hawksbill)</td>
</tr>
<tr>
<td>Boigu</td>
<td>0</td>
<td>0</td>
<td>6; Finfish, turtles, clams and reef-fish</td>
</tr>
<tr>
<td>Dauan</td>
<td>0</td>
<td>0</td>
<td>6; Finfish, turtles, clams and reef-fish</td>
</tr>
<tr>
<td>Erub</td>
<td>0</td>
<td>0</td>
<td>3; Turtles (flatback, green and hawksbill)</td>
</tr>
<tr>
<td>Hammond</td>
<td>0</td>
<td>0</td>
<td>5; Finfish, turtles and sponge</td>
</tr>
<tr>
<td>Yam</td>
<td>0</td>
<td>0</td>
<td>4; Finfish and turtles</td>
</tr>
<tr>
<td>Kubin</td>
<td>0</td>
<td>0</td>
<td>3; Turtles (flatback, green and hawksbill)</td>
</tr>
<tr>
<td>Mabuiag</td>
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<td>0</td>
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</tr>
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<td>Masig</td>
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<tr>
<td>Mer</td>
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<td>0</td>
</tr>
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<td>Poruma</td>
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<td>3; Turtles (flatback, green and hawksbill)</td>
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<tr>
<td>St Paul</td>
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<td>4; Finfish and turtles</td>
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<tr>
<td>Ugar</td>
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<tr>
<td>Warraber</td>
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Communities - Total Impact, 2030

Livelihood (CoWBe) Impact, 2030

-20 -15 -10 -5 0 5

Warraber
Ugar
St Paul
Saibai
Poruma
Mer
Masig
Mabuiag
Kubin
Yam
Hammond
Erub
Dauan
Boigu
Badu

Climate change
- Temperature
- Rainfall
- Sea Level Rise
- Acidification

Human population growth
- Exploitation
- Land use
- Pollution

Impact modelling in Kimbe Bay
Communities - Total Impact, 2030

Livelihood (CoWBe) Impact, 2030

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## Livelihood Impacts, 2030

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Impact modelling in Kimbe Bay
Livelihood Impacts, 2060

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Tim Skewes and Cass Hunter

Phone: (07) 3833 5963, (07) 40595005
Email: tim.skewes@csiro.au
Web: www.csiro.au

Thank you