Key Findings for SWCC NRM Region

Projected Scenarios

The following show the key projected changes that have been determined for the SW NRM region based on two models (MIROC5 and CanESM) under the high emissions scenario (RCP8.5) used by CSIRO and AdaptNRM. These models provide the best case (MIROC5) and worst case (CanESM) scenarios for these changes by 2090.

In particular, it should be noted that these projections have recently been updated and present far worse scenarios than were indicated in previous versions of the strategy.

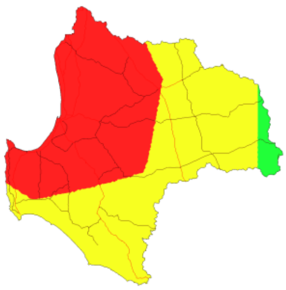
Decrease in Annual Rainfall

Best case scenario

A loss of over 250mm in annual rainfall is projected for the northern jarrah forest and the entire southern coast, while the projected % loss in rainfall is over 25% (over 200mm) for the north-west of the region and never less than 20% for the entire SWCC Region.

In summary, the annual rainfall stress is therefore predicted to be significant over the entire west of the region.

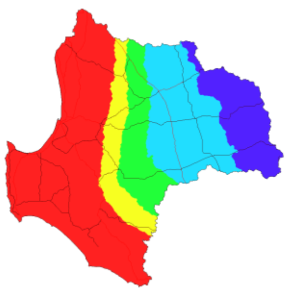
Best Case at 2090 – Annual Rainfall Change (red – loss of over 250 mm; dark blue – loss of less than 100 mm).



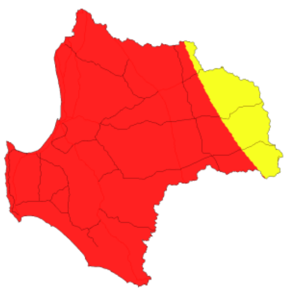
Best Case at 2090 – Annual Rainfall Change as a % of Initial (red – loss of over 25%; green – loss of 15-20%).

Worst case scenario

Almost the entire region is projected to have a greater than 25% drop in annual average rainfall, with a reduction of over 250mm for the entire south and west.



Worst Case at 2090 – Annual Rainfall Change (red – loss of over 250 mm; dark blue – loss of less than 100 mm).



Worst Case at 2090 – Annual Rainfall Change as a % of Initial (red – loss of over 25%; yellow – loss of 20-25%).

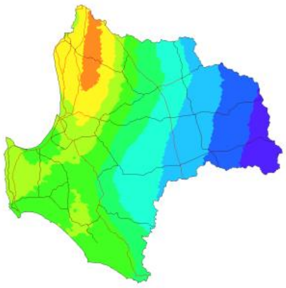
Rainfall Reduction over the Growing Season (May – October)

Best case scenario

Northern near-coastal areas have the highest change in rainfall patterns over the growing season with a projected rainfall reduction of over 200mm (30% of current).

Growing season rainfall stress is also indicated for the southern coast, with a projected rainfall reduction of over 200mm (25-30% of current).

In the far eastern areas, growing season rainfall is projected to drop below 250mm, although the percentage change is less.

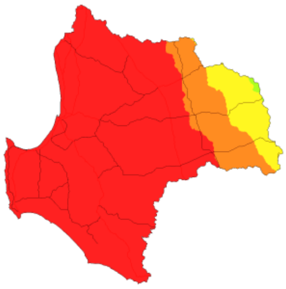


Best Case Growing Season Stress (orange – class 9; dark blue – class 2 where class 10 is the most stressed).

Worst case (CanESM) –

Changes are projected to be significantly more severe, with a projected rainfall reduction of over 200mm (some 30% of current) expected over most of the region.

In addition, the area where growing season rainfall is projected to drop below 250mm extends almost to the centre of the region.

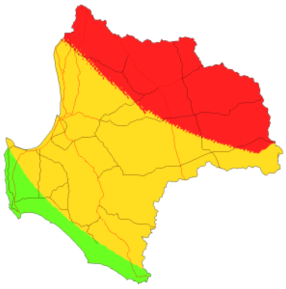


Worst Case Growing Season Stress (red – class 10; green – class 7 where class is the most stressed)

Increase in Temperature

Best case scenario

Expected to be greatest in the north-eastern part of the region, grading south and west, with an annual increase of between 2-3 degrees for the region.



Best Case Temperature Stress (red – class 6; green – class 4 where class 6 is the most stressed)

Worst case scenario

Again, expected to be greatest in the north-eastern part of the region, grading south and west, but with a maximum increase of at least 3 degrees over the entire region, and up to 4.7 degrees in the north-east.

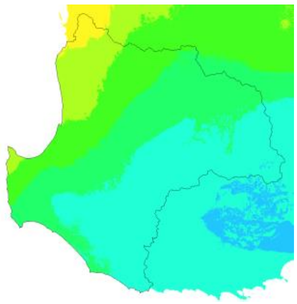
Worst Case Temperature Stress (red – class 6 most stressed)

Climate Impact on Biodiversity

Combined potential degree of ecological change

Best Case scenario

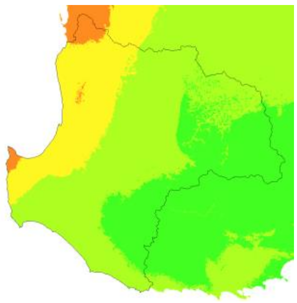
The highest combined impact is projected to occur in the north-west corner of the region, with a change of up to 75% of species.



Best case – climate impact on biodiversity (combined potential degree of ecological change where yellow is the most stressed, dark blue – least stressed)

Worst Case (CanESM)

A very similar pattern to the best case modelled projections can be seen; although with an increase in severity. As well as the highest combined impact being projected for the north-west corner, Cape Leeuwin is projected to be equally impacted, both with a loss of over 80% of species projected.



Worst case – climate impact on biodiversity (combined potential degree of ecological change where orange is the most stressed, dark green – least stressed)

CMIP3 GCMs vs CMIP5 GCMs

A number of Global Climate Models (GCM) have been developed and these are being refined and updated at regular intervals. The CMIP5 GCM is the most recent, having been released by CSIRO in May 2015.

Overall the CMIP5 best case model used is projected to be more severe than the results from the CMIP3 CSIRO model. The worst case model is projected to be significantly more severe.

Where possible, CMIP5 model data is preferred over CMIP3. However, a number of reports released last year have used CMIP3 GCMs and have not been updated to reflect the data from the CMIP5 GCMs. These include:

- Bio-sequestration modelling (Section 9)
- CENRM Species Distribution Models and derived layers (Section 10.7)
- CSIROs weed modelling (Section 12.1)

Recommendations for further work

Component 3: High biodiversity conservation values (section 9.3 and 10.11.5)

Threatened fauna was not incorporated into the model due to the bias and unreliability of the data. Only threatened and Priority 1 rare flora was used on advice from Kim Williams, Department of Parks and Wildife. NCCARF Terrestrial refugia layer was used to capture fauna values.

This component was therefore light in terms of biodiversity input and could possibly be consulted on further and improved.

Although not used in the final bio-sequestration combined output, this layer has been used extensively in other analyses and should be revisited and potentially updated with the AdaptNRM layers and consideration given to the other biodiversity layers included and not included in the analysis such as threatened fauna.

Revisiting this layer through a facilitated MCAS-s process would be very useful in identifying 'current' high biodiversity conservation values and their adaptive capacity. This layer could then be used in conjunction with the AdaptNRM products as suggested in the example framework proposed to be used by North West Local Land Service (Section 10.11.5) to develop a biodiversity prioritisation plan.

- Using the *potential degree of ecological change* as a combined measure of exposure and sensitivity in a risk analysis
- In that risk analysis, combining a binary layer of *potential degree of ecological change* with a binary layer of adaptive capacity to produce four risk categories.
- Crossing those risk categories with a binary layer of current value (from an existing biodiversity prioritisation analysis) to produce eight landscape types that differ in current biodiversity value, degree of potential ecological change, and existing adaptive capacity – low adaptive capacity and/or high potential change constitutes a climate-related risk for areas with high current biodiversity value.
- Using those landscape types, combined with consideration of new principles for biodiversity conservation, to identify priority landscapes for three broad approaches – monitoring future change, maintaining adaptive capacity, and engaging in more advanced adaptation planning.
- For more advanced adaptation planning (for landscapes with high current value and high climate-related risk), using *disappearing ecological environments* and *novel ecological*

environments as well as an understanding of adaptive capacity to consider not just the amount of risk but the nature of the risk as well.

- Using information on new principles, strategic goals, and potential implementation actions to target actions to the nature of the risk (e.g. where novel ecological environments are likely to arise but adaptive capacity may be low, support the assembly of new communities based on native species using connectivity restoration and assisted dispersal if necessary).
- Planning to implement actions based on spatial analyses of their effectiveness in the future. (Prober *et al*., 2015).

The resultant layers could replace the bio-landscapes identified in the biodiversity sub-strategy where the methodology did not weight the different values or use a range of layers (ie. equal value given to threatened flora and fauna records and vegetation associations) or considered climate change.

Identifying current biodiversity values and adaptive capacity of the values could be done without a working group and completed internally but using a working group would add technical rigour to the outcomes. It would also allow discussion around the proposed principles and strategies for biodiversity conservation in a changing climate and the use of AdaptNRMs products.

Recommendation 1: Improve Component 3 of the MCAS-s model, identifying high conservation biodiversity values. Then using this layer in conjunction with the AdaptNRM products and the proposed framework to develop a biodiversity prioritisation plan.

Priority: High

Resources required:

Option 1: Facilitated MCAS-s process and discussion – Consultant (max $15,000 – 2 workshops, data processing and final report)

Option 2: Internal – 20 days (potentially may need some technical support from Simon to convert data layers and provide advice on combining layers)

Combined Bio-sequestration Output – Priority Outcomes (Section 9.5)

The biosequestration report currently presents results based on CMIP3 climate model data in component 1. This could be updated using CMIP5 data.

A brief look at the implications of using CMIP5 best case or worst case models (in place of the CMIP3 growing season rainfall % change) shows that some changes in the protection priority given to specific areas would be expected. Of note are possible changes to the protection priority of areas on the Darling Scarp foothills, which would change from planting to no planting.

The biosequestration working group had extensive input into the creation of the component layers and ultimately the final output layer. To update this component 1, it will then need to be filtered through to the final output and may need to be taken back to the working group for consultation.

Recommendation 2: Update Component 1 of the MCAS-s model using CMIP5 data.

Priority: Medium

Resources required: Consultant – 1 - 2 days; reworking models and writing report.

Component C1A – Climate Impact on Biodiversity (Section 10.4)

Initially created using 3 layers produced by CENRM (plant refugia, plant emigrants and plant immigrant layers; based on CMIP3 data) and the NCCARF Terrestrial Fauna Refugia layer.

We could substitute these CMIP3 data layers with the AdaptNRM 'potential degree of ecological change' layers (four species groups) which were generated using CMIP5 GCMs (Best case – MIROC5; worst case – CanESM2).

The four species groups can be combined in MCAS-s to produce an indicative accumulated biodiversity impact layer. See Section 10.10.

This alternative Component C1A – climate impacts could then be used in the analyses below in place of this original Component C1A.

Recommendation 3: Update Component 1A of the MCAS-s model using AdaptNRM's data.

Priority: Medium

Resources required: Completed.

Component B4 and B5: Combinations for conservation / biodiversity prioritisation (Section 10.5)

Could be very useful model outputs for future Terrestrial Biodiversity planning:

- B4C – identifies areas with high biodiversity/conservation value with an indication of the potential level of threat from climate driven biodiversity-change.
- B4D – identifies areas of DPaW reserve classes (assets) with an indication of the potential level of threat from climate-driven biodiversity change.
- B4E – uses three criteria to identify all areas that combine high or very high biodiversity value and high landscape linkage value but without tenured/security protection.
- B4F - "Lifeboat Areas" – High Biodiversity areas outside linkages and without protection.
- B5B/C – Where critical conservation values may be threatened by climate change.

However, we would need to review and update the other layers (particularly Component 3 and Component C1A). Ideally, these models could be worked through with a working group (in the same way as the bio-sequestration process was undertaken) to allow for technical inputs from stakeholders. See Recommendation 1.

Similarly, CENRM has undertaken Species Distribution Modelling on a number of flora species which we currently use in revegetation projects (Section 10.12). It would be a useful exercise to undertake a case study of two or so species (from different climate response groups as identified by CENRM) to look at the effectiveness of using these revegetation species in current and future projects.

Recommendation 4: Update Components B4 and B5 of the MCAS-s model.

Priority: High

Resources required: This update could be linked with Recommendation 1, with the working group driving the questions (there may be more appropriate outputs than those above).

If Recommendation 1 was completed internally, the outputs above can be updated as part of that process.

Recommendation 5: Prepare case studies for revegetation species used by SWCC to guide project planning.

Priority: Medium
Resources required: Internally – 5 days for two or so species

Aquatic Biodiversity – Framework for assessing vulnerability (section 10.13)

The Centre for Excellence in NRM (CENRM) are currently undertaking a vulnerability analysis for the Blackwood Catchment. They are looking at four specific key drivers of change, i.e. climate change (projected changes in rainfall and temperature), salinity, nutrient enrichment and hydrological change and are determining the vulnerabilities of a number of key species in relation to these drivers. In undertaking this work, they have developed a framework that could be applied to other south west rivers, with many of the species responding to the drivers of change in the same way.

The framework 'scores' native species against each of the four threats based on their vulnerability (1 being low vulnerability, 3 being high vulnerability) for exposure, sensitivity and adaptive capacity. For each species and each threat assessed, the exposure score is multiplied by the sensitivity and the adaptive capacity scores to generate four separate threat vulnerability indices, one each for climate, salinization, nutrient enrichment and hydrological change. These four scores are summed and standardised (scored out of 100) to obtain a Threats Vulnerability Index (TVI).

Recommendation 6: Using the results of the Blackwood River Analysis, identify priority sites for investment and idenitfy principles and strategies for action along similar lines to those being proposed by AdaptNRM for biodiversity conservation, see recommendaiton 1.

Priority: Medium – High
Resources required: Internally – 5 days NB: there are plans to prepare an electronic report card using the results of the analysis once available to go onto the website.

Recommendation 7: Explore the usefulness of the framework and the resources required to undertake the assessment all or a selection of rivers of the region and develop a Aquatic Biodiversity prioritisation framework.

Priority: Medium - High
Resources required: Internally

Other Areas Needing Attention

Agriculture (Section 11)
High quality agricultural land has not been identified as a dataset by DAFWA but was created as part of the biosequestration process in consultation with the working group members. However, the layer is a composite layer that includes projected yield data and growing season rainfall data from CMIP3. The Growing Season Rainfall data can be updated with CMIP5 easily however an updated version of the projected yield data is not available.

Observational changes in rainfall (annual, May-October and May-July) compared to historical has been provided by DAFWA.

Recommendation 8: Determine usefulness of high quality agricultural land layer (updated with CMIP5 – growing season rainfall; but still relying on CMIP3 derived projected yield data) and observational changes, in advising SWCC Land Resources priorities.

> **Priority:** Medium
> **Resources required:** This is a difficult one, as will require close cooperation with DAFWA, and they may not be able to allocate resources towards it in the near future.

Weeds (Section12)
Species' potential distribution modelling has been undertaken for a number of significant national weed species. From this modelling, we can identity new weed threats from outside of the SWCC NRM Region, existing weed threats that may get worse and existing weed threats that may lessen. The modelling is based on CMIP3 GCMs.

AdaptNRM's weed management guidelines provides examples of potential adaptation responses at a national scale, but could be applied at the regional scale.

Cape to Cape Catchment Group have just completed a regional weeds strategy but on first inspection does not address climate change and the need for monitoring and awareness of species that pose an increased threat under changing climatic conditions.

(Sub) Regional scale weed strategies are likely to be developed by several Regional Biosecurity Groups within the SW NRM Region. It is unlikely they will be developed with a strong consideration of climate change affects and interactions with weeds. Resources may need to be allocated to ensure the full learnings from the SW Regional Strategy process and the AdaptNRM Resources available.

Recommendation 9: Assess the need to develop a regional weed management strategy as a sub-set of the Regional NRM Strategy that incorporates the projected effects of climate change.

> **Priority:** Low
> **Resources required:** internal assessment

Sea Level Rise and Marine Intrusion (Section13.1)

Projections for the South West Flatlands cluster have been provided by CSIRO and BoM. Two local scale modelling projects have been conducted for Bunbury and Busselton.

- Coastal Inundation Modelling for Busselton, WA under Current and Future Climate (Martin et al., 2014).
- Storm surge modelling for Bunbury, WA; Professional Opinion (Fountain et al., 2010).

A Coastal Hazard Risk Management Adaptation Plan (CHRMAP) is currently being developed for the Shire of Harvey as a case study.

Work along these lines is being undertaken by local governments through the Peron Naturaliste Partnership (PNP) and SWCC should explore cooperative partnerships with PNP to develop this further.

Recommendation 10: Work along these lines is being undertaken by local governments through the Peron Naturaliste Partnership (PNP) and SWCC should explore cooperative partnerships with PNP to develop this further.

> **Priority:** medium
> **Resources required:** Internal

Marine Acidification (Section 13.2)

Projections for the South West Flatlands cluster have been provided by CSIRO and BoM; with very high and high confidence levels.

Recommendation 11: Determine the need for consideration of marine acidification as part of SWCCs Regional NRM Strategy

> **Priority:** medium
> **Resources required:** unknown

Community and Culture (Section14)

The AdaptNRM Checklist raises a number of questions around the consideration of how the region's social systems are likely to be impacted by climate change and the capacity of these systems to absorb such impacts.

For example, Aboriginal and European culturally significant sites will no doubt be impacted by climate change. The natural sites (e.g. waterways) will be impacted as described in above sections while infrastructure may be impacted on significantly by extreme events and bushfire.

These questions should be taken into consideration in undertaking adaptation planning for climate change; however the scope of the NRM Strategy in relation to these issues perhaps needs to be defined.

Recommendation 12: Determine the need for consideration of climate impacts on community and culture as part of SWCCs Regional NRM Strategy.

Priority: medium

Resources required: to determine the need and scope of the need – one RCT meeting perhaps? 2-3 days to prepare for meeting

Adaptation Planning

AdaptNRM have published a technical guide, "NRM Adaptation Checklist: Supporting climate adaptation planning and decision-making for regional NRM" Technical Guide (Rissik et al. 2014), which outlines the adaptation planning process and the challenges that NRM Regional bodies face with regards to incorporating climate change into their strategic plans.

The four key challenges associated with adapting to climate change in NRM planning are identified as being:

1. Making decisions for multiple possible futures;
2. Employing flexible and adaptive planning processes;
3. Explicitly identifying and preparing for likely future decisions; and
4. Strengthening the adaptive capacity of people and organisations.

We have attempted to address the self-reflective questions from the Checklist Technical Guide for the SW NRM Region in Appendix 2.

Recommendation 13: Review the self-reflective questions and determine way forward with Strategic Planning for the organisation and its stakeholders.

Priority: High

Resources required: Consultant to develop strategic planning process (planned) followed by SWCC staff time and partner/stakeholder time to implement, review and refine the process on an ongoing basis. The amount of resources required for this will be defined by the outputs of the consultant's work.