PGR Management in the 21st Century

Crop Wild Relatives:

climate change and niche modelling

Rob van Treuren

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UNIVERSITY & RESEARCH

Centre for Genetic Resources, The Netherlands (CGN)

Crop Wild Relatives: CC and SDM

- Terms & abbreviations
  - Crop wild relatives (CWR)
    - Wild ancestor of the domesticated plant,

      or another closely related taxon
  - Climate change (CC)
    - Change in global or regional climate patterns from mid to late 20th century onwards - attributed largely to increased levels of greenhouse gasses
  - Species distribution modelling (SDM)
    - Process of using computer algorithms to predict the distribution of species on the basis of their known distribution

Crop Wild Relatives: CC and SDM

- Background
  - CWR are important to plant breeding and thus global food security
  - CWR are mainly conserved *in situ*
    - CC threatens the continued existence of these CWR
    - Access to CWR is very limited *in situ*

Example: resistances for tomato

Root-knot nematode from *L. peruvianum*

Verticillium from *L. pimpinellifolium*

ToMV from *L. peruvianum*

TYLCV from *L. chilense*

TSWV from *L. peruvianum*

Cladosporium from *L. pimpinellifolium*

Stemphilium from L. *pimpinellifolium*

Fusarium o.l. from *L. pimpinellifolium*

Example: resistances for lettuce

Bremia lactucae genes from *L. sativa, L. serriola, L. saligna en L. virosa*

LMV from *L. sativa* or *L. serriola*

BWYV from *L. sativa*

Nasonovia from *L. virosa*

Root lice from *L. sativa*

Potato aphid from *L. serriola*

Corky root from *L. serriola*

RIJK ZWAAN

WAGENINGEN UR
For quality of life

CGN collecting expeditions of CWR

2008 – spinach: Tajikistan & Uzbekistan

2009 – leek: Greece

2011 – spinach: Armenia, Azerbaijan & Georgia

2012 – asparagus: Armenia & Azerbaijan

2013 – lettuce: Armenia & Azerbaijan

2015 – carrot: Kirgizia & Uzbekistan

Crop Wild Relatives: CC and SDM

- CWR in the Netherlands now and in the future
  - What CWR exist in the Netherlands?
  - What is the current and future level of threat?
  - How can conservation be improved?

Crop Wild Relatives: CC and SDM

- Inventory of CWR in the Netherlands
  - Step 1: determine economically most important crops for agri- and horticulture in the Netherlands and in the world
    - Data from FAO, CBS/LEI, variety lists
    - Result: 207 crops
  - Step 2: determine the CWR of these crops
    - Data from ‘FLORON Verspreidingsatlas’
    - Species of same genus as crop
    - Crossability with crop species

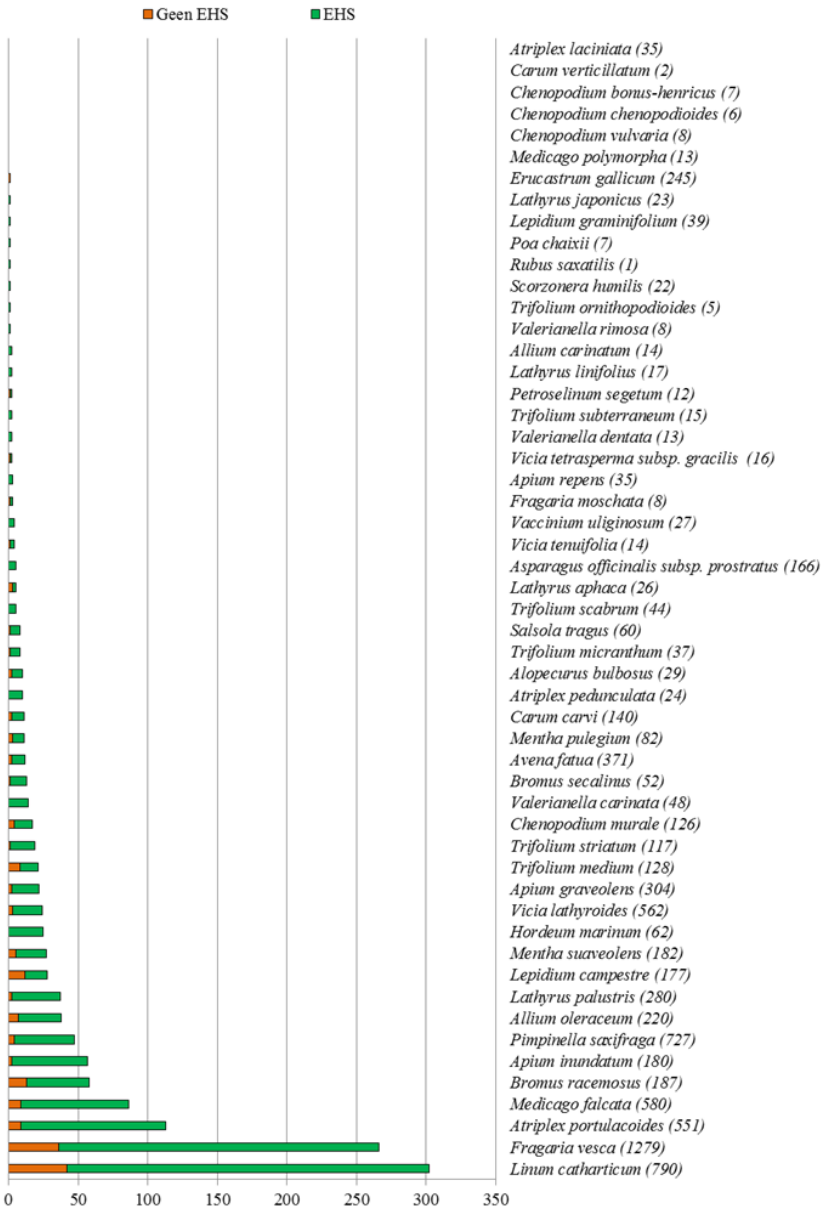
Crop Wild Relatives: CC and SDM

Crop group	Common	Red list	Total
Cereals	18	5	23
Vegetables	34	17	51
Fruits	20	4	24
Oil crops	9		9
Herbs	5	4	9
Leguminous crops	15	7	22
Sugar crops	1		1
Others	59	16	75
Total	**161**	**53**	**214**

Crop Wild Relatives: CC and SDM

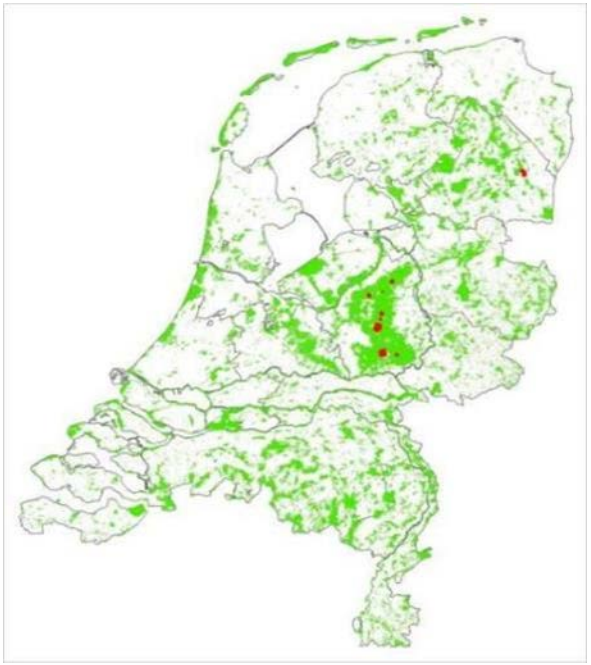
- Inventory of CWR in the Netherlands
  - Step 3: collect detailed distribution data for Red List species
    - In collaboration with FLORON
    - Data from 2000-2015
    - Occurence per km square
    - Coverage National Ecological Network
    - Occurence in protected areas by national organisations (SBB and NM)

Crop Wild Relatives: CC and SDM



Scorzonera humilis L.

Kleine schorseneer



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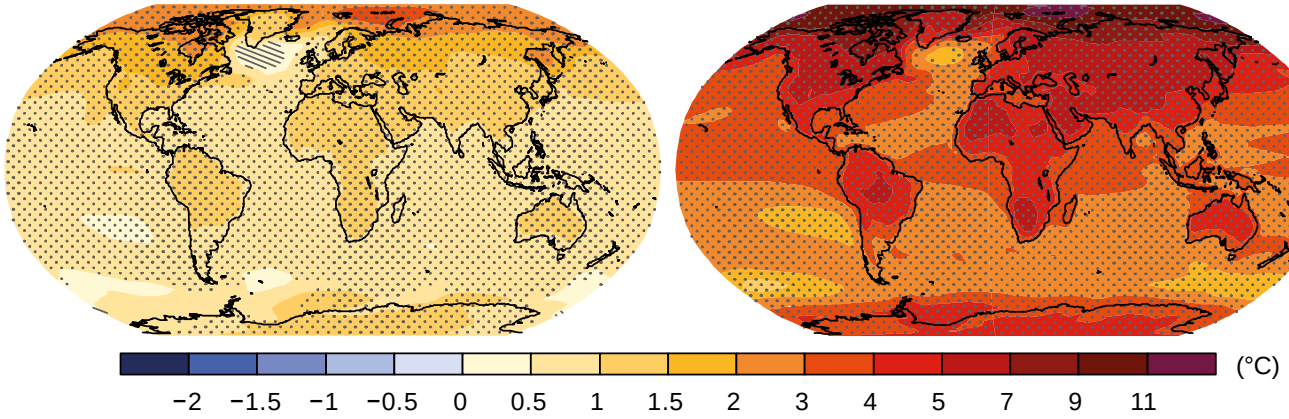
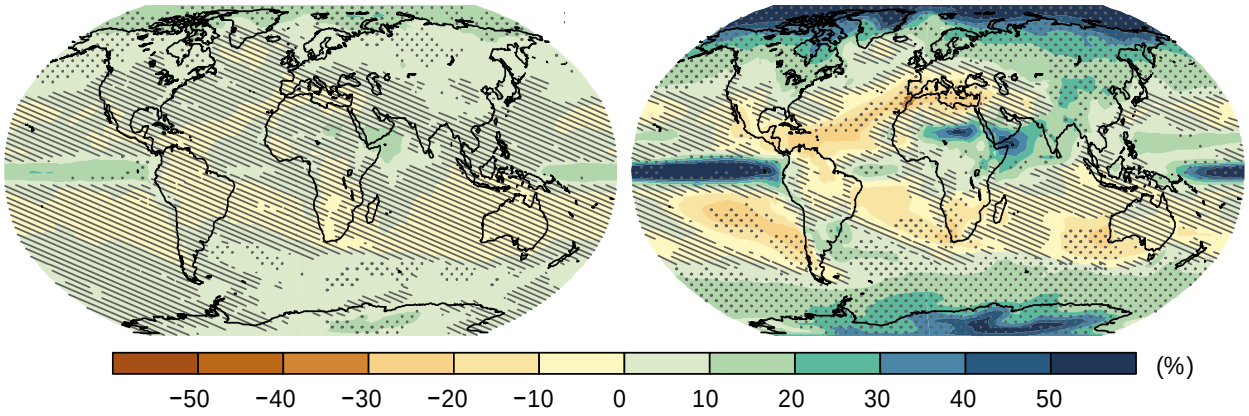
Crop Wild Relatives: CC and SDM

Change in average temperature (1986-2005 to 2081-2100)



Change in average precipitation (1986-2005 to 2081-2100)



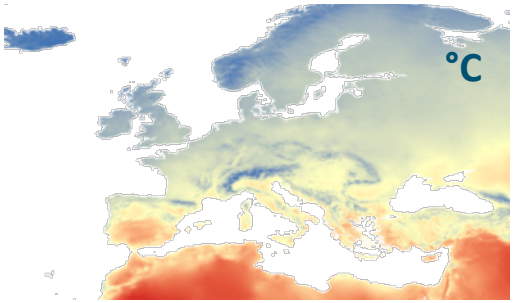
Optimistic scenario (RCP2.6)

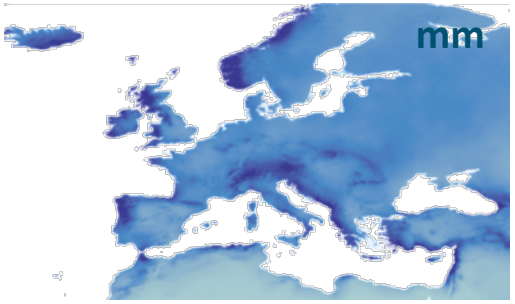
Pessimistic scenario (RCP8.5)

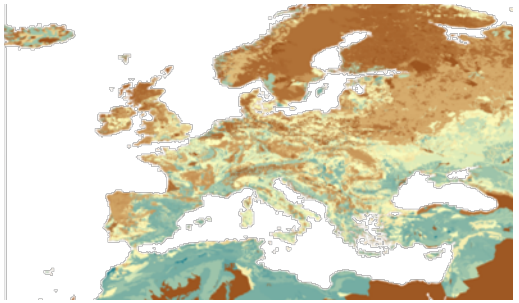
Crop Wild Relatives: CC and SDM

- Species distribution modelling
  - Prediction of species distribution based on known distribution

Crop Wild Relatives: CC and SDM







Temperature variables

- Max temperature of warmest month
- Min temperature of coldest month
- Mean temperature of wettest quarter
- Temperature seasonality

Precipitation variables

- Precipitation of driest month
- Precipitation seasonality
- Precipitation of wettest quarter

Soil variables

- pH
- Organic carbon

***5x5 km**

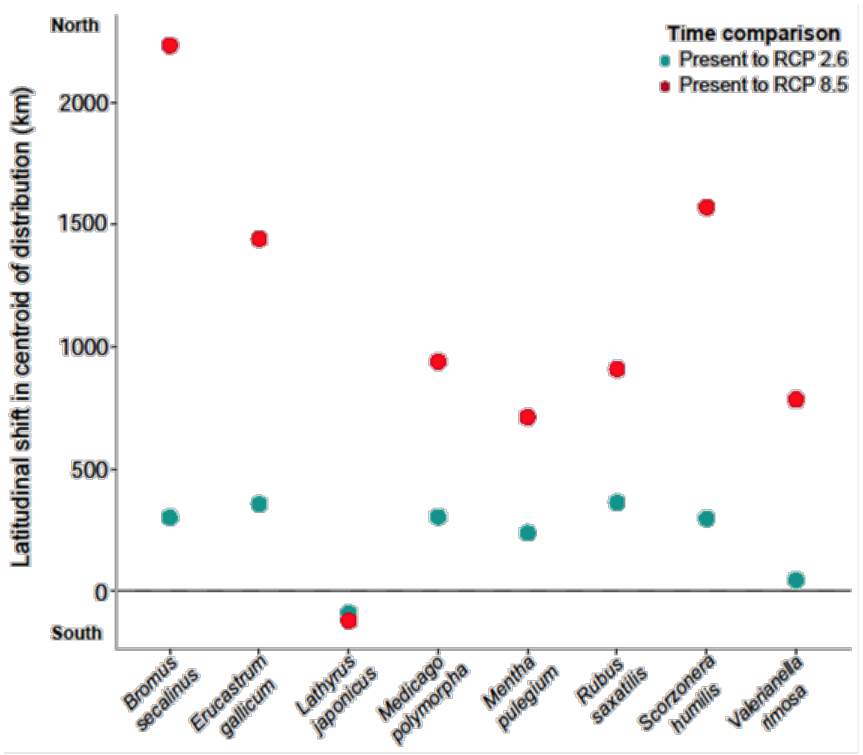
***Corr≤|0.7|**

Crop Wild Relatives: CC and SDM

- Inventory of CWR in the Netherlands
  - Step 4: predict distribution of CWR under two CC scenarios
    - In collaboration with Naturalis
    - Initially Red List species
    - Using SDM with panel of 3 models
    - Predictions for 2070
    - Projected distribution in the Netherlands and Europe

Crop Wild Relatives: CC and SDM

- Inventory of CWR in the Netherlands
  - Step 4: predict distribution of CWR under two CC scenarios
    - Latitudinal shifts



Crop Wild Relatives: CC and SDM

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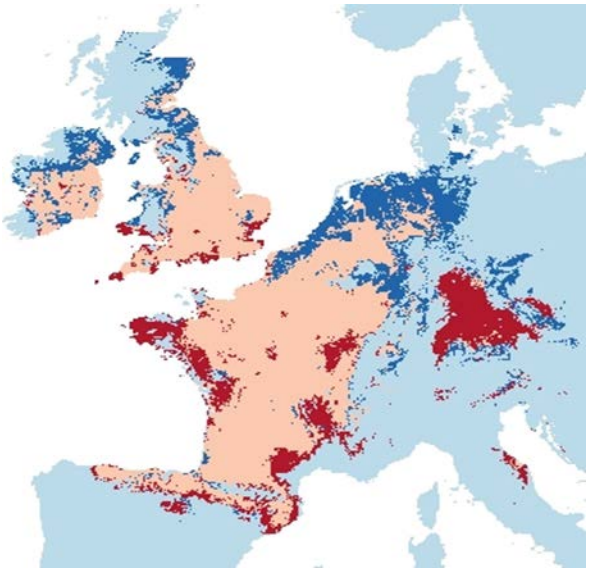
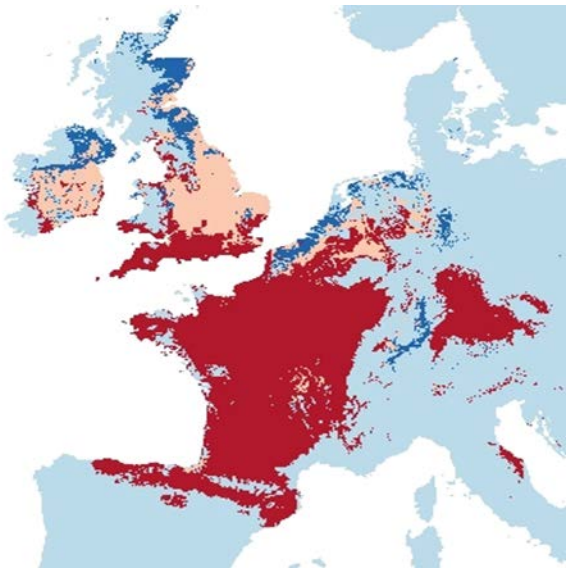
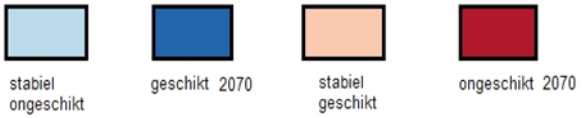


Optimistic scenario

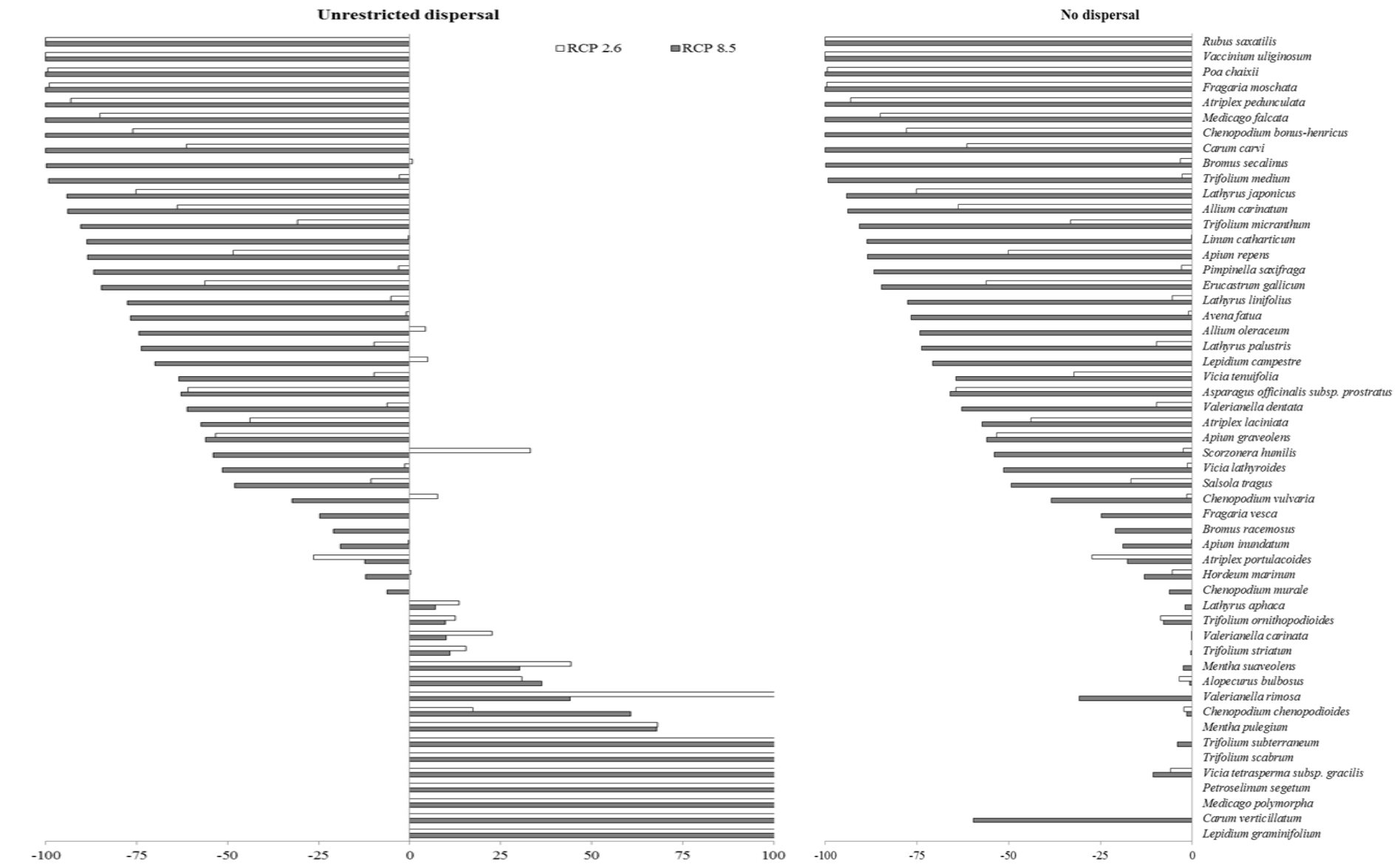


Pessimistic scenario



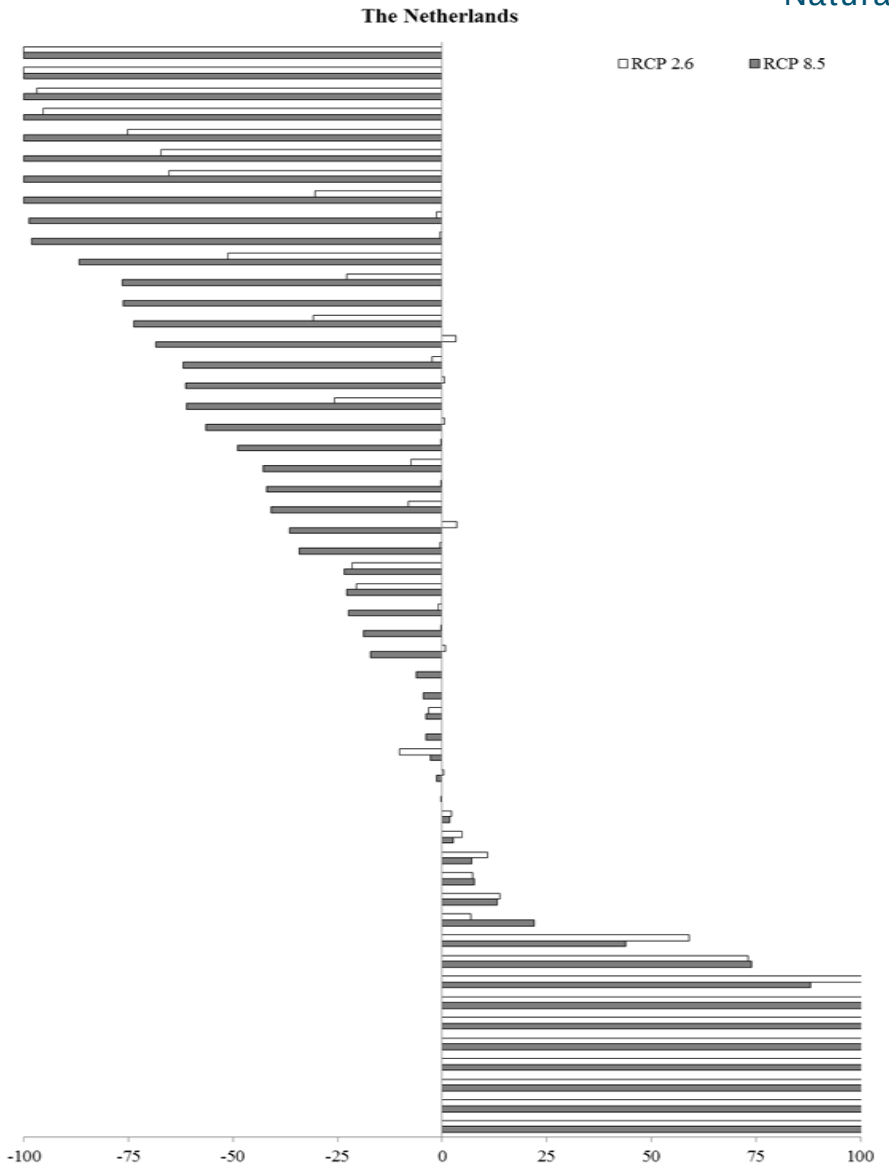
Valerianella rimosa
Geoorde veldsla

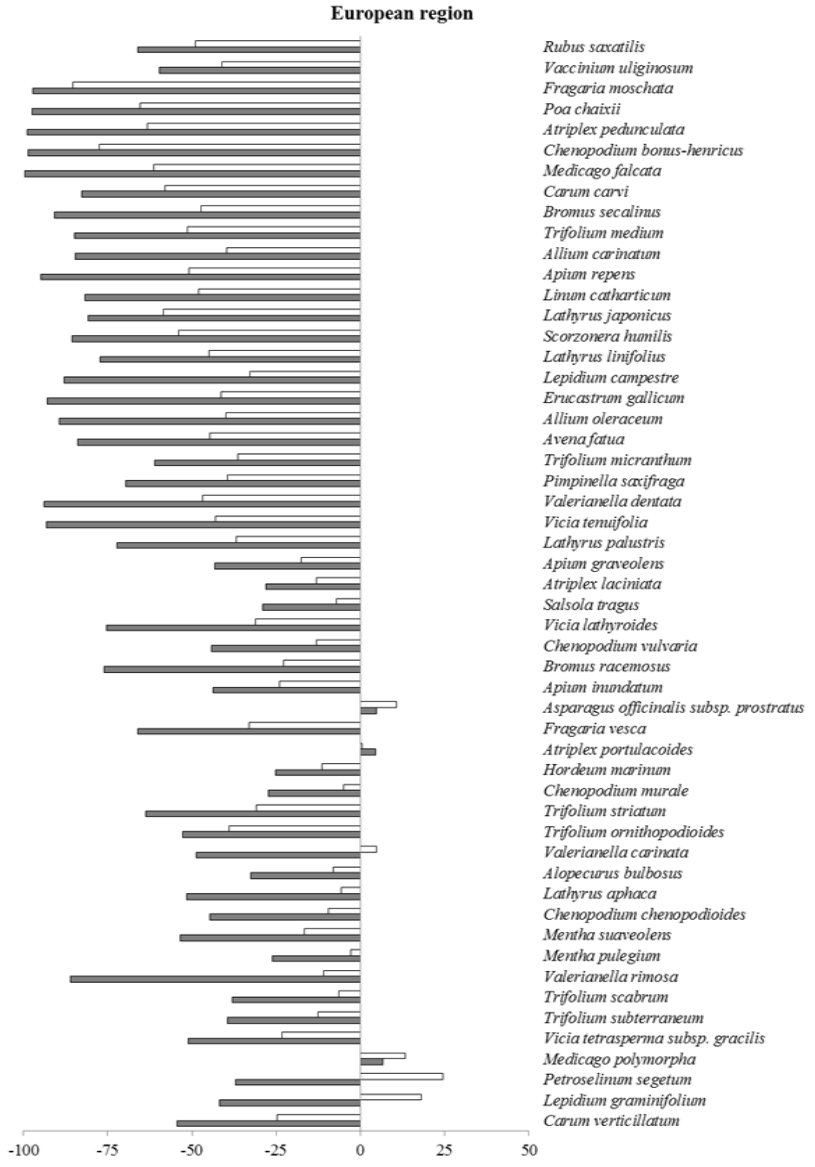
Crop Wild Relatives: CC and SDM



Crop Wild Relatives: CC and SDM

Natura 2000





Crop Wild Relatives: CC and SDM

- Inventory of CWR in the Netherlands
  - Step 5: prioritize for conservation
  - Six factors with equal weights
    - Crop relationship
    - Trend in the Netherlands since 1950
    - Existence in large protected NL populations
    - Conservation status in neighbouring countries
    - Effect of CC in the Netherlands
    - Effect of CC in the European region

Crop Wild Relatives: CC and SDM

Species	Crop relationship	Trend in The Netherlands since 1950	Large protected Dutch populations	Conservation status in neighbouring regions	Effects of climate change in The Netherlands	Effects of climate change in the European region	Overall priority
Chenopodium bonus-henricus	3	5	5	3	5	5	4.3
Fragaria moschata	3	5	4	3	5	5	4.2
Atriplex pedunculata	1	5	3	4	5	5	3.8
Apium repens	1	5	4	5	4	3	3.7
Erucastrum gallicum	4	4	5	1	4	4	3.7
Poa chaixii	1	4	5	3	5	4	3.7
Asparagus officinalis subsp. *prostratus*	4	3	4	4	4	2	3.5
Carum carvi	1	5	3	3	4	4	3.3
Rubus saxatilis	1	5	5	1	5	3	3.3
Allium carinatum	1	1	4	5	4	4	3.2
Carum verticillatum	1	5	5	4	1	3	3.2
Medicago falcata	5	3	1	1	5	4	3.2
Scorzonera humilis	1	4	5	3	2	4	3.2
Apium graveolens	1	5	2	3	4	3	3.0
Atriplex laciniata	1	4	5	3	3	2	3.0
Chenopodium vulvaria	1	4	5	4	2	2	3.0
Lathyrus japonicus	1	1	5	3	5	3	3.0
Vaccinium uliginosum	1	3	4	2	5	3	3.0
Valerianella dentata	1	5	4	3	2	3	3.0
Valerianella rimosa	1	5	5	4	1	2	3.0
Avena fatua	5	3	3	1	2	3	2.8
Hordeum marinum	3	5	1	4	2	2	2.8
Lathyrus linifolius	1	5	4	2	2	3	2.8

Grote bosaardbei

Brave Hendrik

Centre for Genetic Resources, the Netherlands

Crop Wild Relatives: CC and SDM

- Inventory of CWR in the Netherlands
  - Step 6: develop policy for protection
    - Objectives
      - Improve security CWR
      - Make material available for research and breeding
      - Raise (public) awareness
    - Establish contact with protecting agencies
      - Bilateral communication
      - Publications and presentations for communities

Crop Wild Relatives: CC and SDM

- Inventory of CWR in the Netherlands
  - Step 6: develop policy for protection
    - Development website: CWRnl
      - Results of the inventory
      - Information on CWR species
      - Links to protected areas
      - Effects CC
    - Publications

Van Treuren (2016) Wilde verwanten van voedselgewassen: het behouden waard! Planten 3: 4-5.

Aguirre-Gutiérrez J, van Treuren R, Hoekstra R, van Hintum TJL (2017) Crop wild relatives range shifts and conservation in Europe under climate change. Divers & Distrib 00: 1-12. https://doi.org/10.1111/ddi.12573

Van Treuren R, Hoekstra R, van Hintum TJL (submitted)) Inventory and prioritization for the conservation of crop wild relatives in The Netherlands under climate change. Biological Conservation.

Crop Wild Relatives: CC and SDM

- Inventory of CWR in the Netherlands
  - Future activities
    - SDM for 161 non Red List CWR
    - Meta analysis all 214 CWR
    - Translation CWRnl in English
    - Strategic note on the conservation of CWR

      in the Netherlands for policy makers