Why forest genetic resources matter?

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Sustainable, close-to-nature, multifunctional forest management.

Small-scale flexible forest management, adapted easily to site characteristics and natural development of forests.

Active protection of natural populations of forest trees.

Protection and conservation of biological diversity in forests.

Support of the bio-ecological and economical stability of forests by improving the growing stock.

Tending of all developmental stages and all forest forms for supporting of vital and high-quality forest trees, which could fulfil optimally all functions of forests.

Natural regeneration is supported in all forests.

If seedlings are used, they should derive from adequate seed sources / provenances, and only adequate species can be used.
Simulations of CC effects on tree distribution ranges in European Forests

Vulnerability of dynamic genetic conservation units of forest trees in Europe to climate change

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Distribution areas of Fagus sylvatica & Picea abies
Selected examples of negative effects on forest & how to solve them – prepared by contacted national experts

The list prepared for/by:

- **Croatia**, by Prof. Davorin Kajba, Dr. Mladěn Ivanković, Dr. Nevenka Ćelepirović
- **Hungary**, by Dr. Sándor Bordács, nébih
- **Poland**, by Dr. Jan Kowalczyk
- **Serbia**, by Prof. Saša Orlović, Dr. Srdjan Stojnić

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<th>Greece</th>
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<td>• ignorance of FGR diversity importance</td>
<td>• illegal logging, diseases and pests</td>
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<td>• tree dieback in lowland region</td>
<td>• fragmentation in densely populated areas and prime agricultural areas</td>
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<td>• over-exploiting of forests</td>
<td>• complicated state organization and overlapping of jurisdictions</td>
<td>• tourism development in nature protection areas</td>
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<td>• no state level policy for protection of FGR and gaps</td>
<td>• Pests and diseases, alocchtonous trees species</td>
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<td>• poor state of private forests</td>
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<td>• lack of public awareness about significance of FGR</td>
<td>• low level of underground water in lowland areas</td>
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Hungary - Negative effects on forests and forest genetic resources (FGR)

1. Climate change effects, extreme weather conditions
2. Invasive species, diseases and their high competitiveness
3. Increasing costs of handwork, less capacity of handicraft in silviculture
4. Increasing demand on industrial wood

Poland - Main challenges regarding FGR

1. Influence of climate change (windstorms, temperature increase) on FGR management, utilisation and conservation
   →It is estimated the storms brought down over eight million cubic metres of lumber across 80,000 hectares of forest.
2. Active protection of FGR through adaptive forest management practices and tree breeding
3. Social aspect and acceptance of management of forests including FGR
Possible solutions to country-envisioned threats to FGR

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<td>1. <strong>Preparation of national strategies</strong> on FGR</td>
<td>1. assisted migration, genetic monitoring, improvement on populations’ adaptive plasticity</td>
<td>1. Strong forestry sector and possibility to incorporate decision at a wide scale</td>
<td>1. increasing public awareness on the importance of FGR for SFM</td>
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<td>2. <strong>Communication with forest owners</strong> on quality of higher values seeds (bread for resistance), and/or subsidies from the State for their use.</td>
<td>2. resistance breeding,</td>
<td>2. Good infrastructure and human capacity (including original, localy developed know-how, and introduced into the practice)</td>
<td>2. integration of FGR into forestry and biodiversity legislation, strategies, programmes &amp; action plans</td>
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<td>3. <strong>Raising awareness</strong> about the conservation and economic value of these seeds</td>
<td>3. improvement of silvicultural methods,</td>
<td>3. Cooperation at the country and international levels</td>
<td>3. promotion of inter-sectorial cooperation on FGR</td>
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<td>4. <strong>Active search for FRM</strong> that is adapted to climate change, before spp. become seriously endangered</td>
<td>4. breeding for plantations with intensive machinery</td>
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<td>4. application of more intensive <em>ex situ</em> conservation measures</td>
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<td>5. <strong>Positive:</strong> policy makers already realise that FGR are important also from an economical point of view</td>
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<td>5. improvement of research activities on within species genetic diversity</td>
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Croatian seed orchard and collected improved seeds
Biodiversity at different scales

- **Ecosystem, species & functional diversity can diminish the impacts of stress and disturbances.**
- **Genetic diversity (GD) ensures that future populations of forest trees can survive, adapt & evolve in changing environmental conditions.**
Measures for Genetic Protection of forests

- Every measure to be considered with respect to its impact on genetic diversity of the stand/population(s)
- Support natural regeneration,
- Assist regeneration by co-planting and co-sawing of a high number of tree species based on site-matching (enrichment planting),
- Use adequate forest reproductive material (FRM) of high genetic diversity, through:
  - i) Defining the minimum number of seed trees for FRM production,
  - ii) Collection of FRM in full mast years,
  - iii) Controlled & prescribed mixing of seed units,
- Use advanced seed and seedling production systems,
- Test provenances for transfer and mixing of FRM.
LIFEGENMON - LIFE for European forest genetic monitoring system (2014 - 2020, LIFE Environmental fund, 5.4 M€)

⇒ FOREST GENETIC MONITORING (FGM) = an early warning system to aid the assessment of a species response to environmental change at a long-term temporal scale

⇒ Monitor changes in GD in time
  ⇒ following forest management & operations
  ⇒ to observe consequencies of changing environment before visual deterioration

⇒ Implement forest genetic monitoring - locally, nationally & across borders

⇒ Supports measures for Genetic Protection of forests
The contribution of tree-soil metagenomes to forest resilience – IPBES & Global Soil Biodiversity Initiative

- Mechanisms that facilitate species coexistence in complex communities
- Metagenomics in Forest Genetic Monitoring offers a better understanding of ecosystem functioning, stability and evolution of a natural population
DIVERSITY OF ECTOMYCORRHIZA

(Photos M. Hrenko, T. Grebenc, T. Mrak, I. Štraus, H. Kraigher)
Common Mycelial Networks (CMN)

- Translocation of C, N, P between plants through CMN:
  - C (Simard et al 1996 – 13C from birch into shaded Douglas fir),
  - N (Arnebrant et al 1993 – 15N through Frankia to Alnus and through Paxillus to Pinus,
  - P (Lindahl et al 2001 – 32P from Hypholoma through Suillus to Pinus)

- Mineralisation:
  - ‘Rock-eating’ fungi (Jongmans et al 1997)

- Biodiversity belowground supports diversity above ground:
  - Increasing site productivity (Read 1998 & van der Heijden et al 1998)

- Water relations:
  - Hydraulic lift & retranslocation of water within hubs from old to small trees (Simard et al group 2014)

- Mycorrhiza induced resistance (Cameron et al 2013)
Co-migrations of mycorrhizal fungi and forest tree species in Europe

Phylo-geography of Tuber & Quercus (Dr. Tine Grebenc et al 2010)
Microscopy with ZEISS StereoLUMAR.V12, AxioImager.Z2 & AxioObserver.Z1 with the PALM Microbeam laser microdissection system (Dr. Tanja Mrak)

Forest physiology and genetics: fully equipped labs for molecular genetics (molecular databases for European tree spp spruce, beech, fir, oaks, ash; & fungi), physiology of seed & seedlings, and an underpressurized clean room with growth chambers (for GMOs, quarantine pests & diseases) (Marko Bajc)

Collections:
The Slovenian Forest Gene Bank (with the National list of FRM – as the State authority for approval of seed objects and certification of FRM) (Prof. dr. Hojka Kraigher),
Living collection of ectomycorrhizal fungi (Dr. Tine Grebenc), with reference samples included in Mycotheca & Herbarium SFI, Living archives, clonal collections (Populus nigra & hybrids) and provenance tests (the International trial with 38 provenances of Fagus sylvatica) (Dr. Gregor Božič)
Cooperation within the Global Timber Tracking Network
(Prepared by Dr. Marjana Westergren, SFI member of the IUFRO WP 7.01.02)

Aim: develop scientific standards & laboratories to fight illegal logging

- **First WG** group meeting in Washington DC (October 2017): *standardization of methods and protocols*
- Needs for *Wood anatomy, Genetics, Stable isotopes & Chemistry* (chemical composition of wood) laboratories
- **Forensic vs. solid and transparent science approach**
- **Validation of laboratories** in development: certification possible
- Next step for developing harmonized methods: *case studies* on tree spp for which samples for all 4 types of analysis are already available; participation of SFI

We are hoping for development of common research strategies among 16 + 1 countries for sustainable future forests, forestry and forest science!