Forest Management for a Changing Climate, Market and Society

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Research Perspectives on the Optimal Use of Forest Biomass

University of Limerick, September 28, 2016

Overview of presentation

- Background / relevant research drivers
  - Climate change
  - Market change
  - Societal change
- Four research projects:
  - INTEGRAL: ecosystem services, landscape, integrated, potential futures, owner types, management approaches
  - ALTERFOR: risk, climate change, markets, landscape, alternative management approaches, spatial analysis
  - FASTFORESTS: intensification of timber production, spacing and thinning, rotations, climate change
  - SIMWOOD: wood mobilisation, sale of harvest residues, biophysical and economic restrictions
- Closing remarks

Climate change

- Increased risks due to climate change
  - Wind
  - Drought
  - Flooding
  - Pests & diseases
  - Fire
- Need for tools that incorporate risk into management planning
- Proactive planning for new risk factors
- Land-use change within landscapes
- Changes to species selection and productivity
- Silviculture and management may need to change

Markets

- Demand for biomass, wood-based products, sawnwood, carbon, non-wood forest products, bio-refinery?
- Current management models based on maximal sawlog production
- Target tree size now down to 0.6 m^3: proportion of juvenile wood?
- Can all markets be supplied or should choices be made? Based on economics only?
- New markets: increased profitability for owners?
- Requirement for certification for all products?
- Need for tools to help owners / managers link silviculture and management to local markets

Society

- Implementation of Sustainable Forest Management policy
- Increase in private versus public forest ownership → owner types
- Changing societal demands for forestry
  - Amenity, landscape, recreation
  - Environment – protection of water, soil, habitat (deer management?)
  - Energy, timber, non-wood forest products
  - Jobs
  - ?

Climate, Markets, Society

How to manage forests to satisfy, as much as possible, societal and market demands while adapting to climate change?

- Concept of ecosystem services is useful
- Integrative management versus segregative management
- Should all ecosystem services be valued (natural capital) or can they be compared using other quantitative assessment methods?
- Owner types are important
- Owner type proportions will change over time
- Involvement of local level stakeholders in landscape level land-use and forest management planning
- Inclusion of local (developing) markets in forest management planning
- Include climate change effects on species choice, productivity and risk

INTEGRAL

Future-oriented integrated management of European forested landscapes

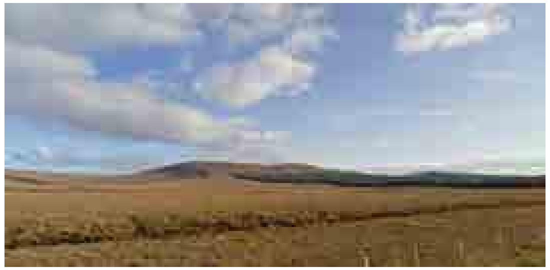
Backgound

- Critical inconsistencies exist within and between trans-national, national and local forest-related land-use policies
- There is a need to improve existing policy and management approaches to deliver a better balance between multiple and conflicting demands for forest goods and services

The main objectives of INTEGRAL are to identify policy mismatches and to provide a new policy and management approach that is sensitive to ecological, socioeconomic and political issues

PhD students: Edwin Corrigan and Nana Bonsu

Irish Case Study landscapes

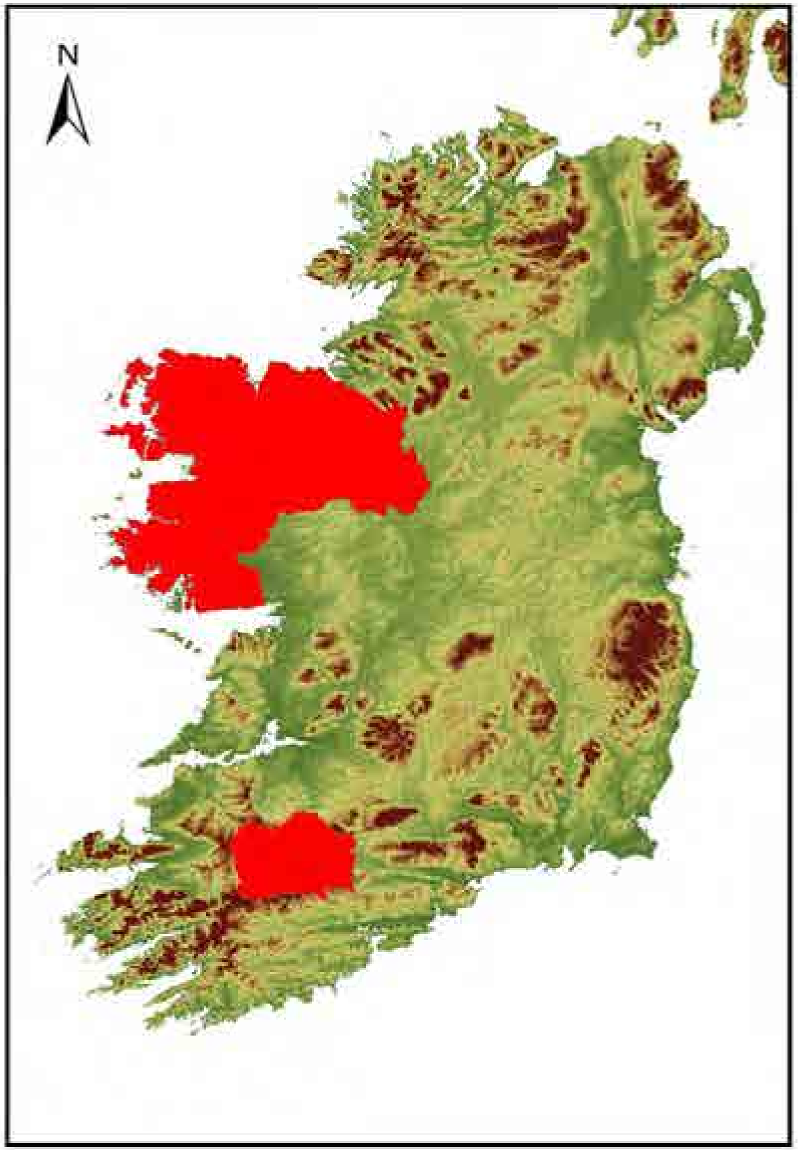


Western Peatlands

Issues: water quality, economics, recreation, landscape

Newmarket

Issues: social cohesion, afforestation, hen harrier, water



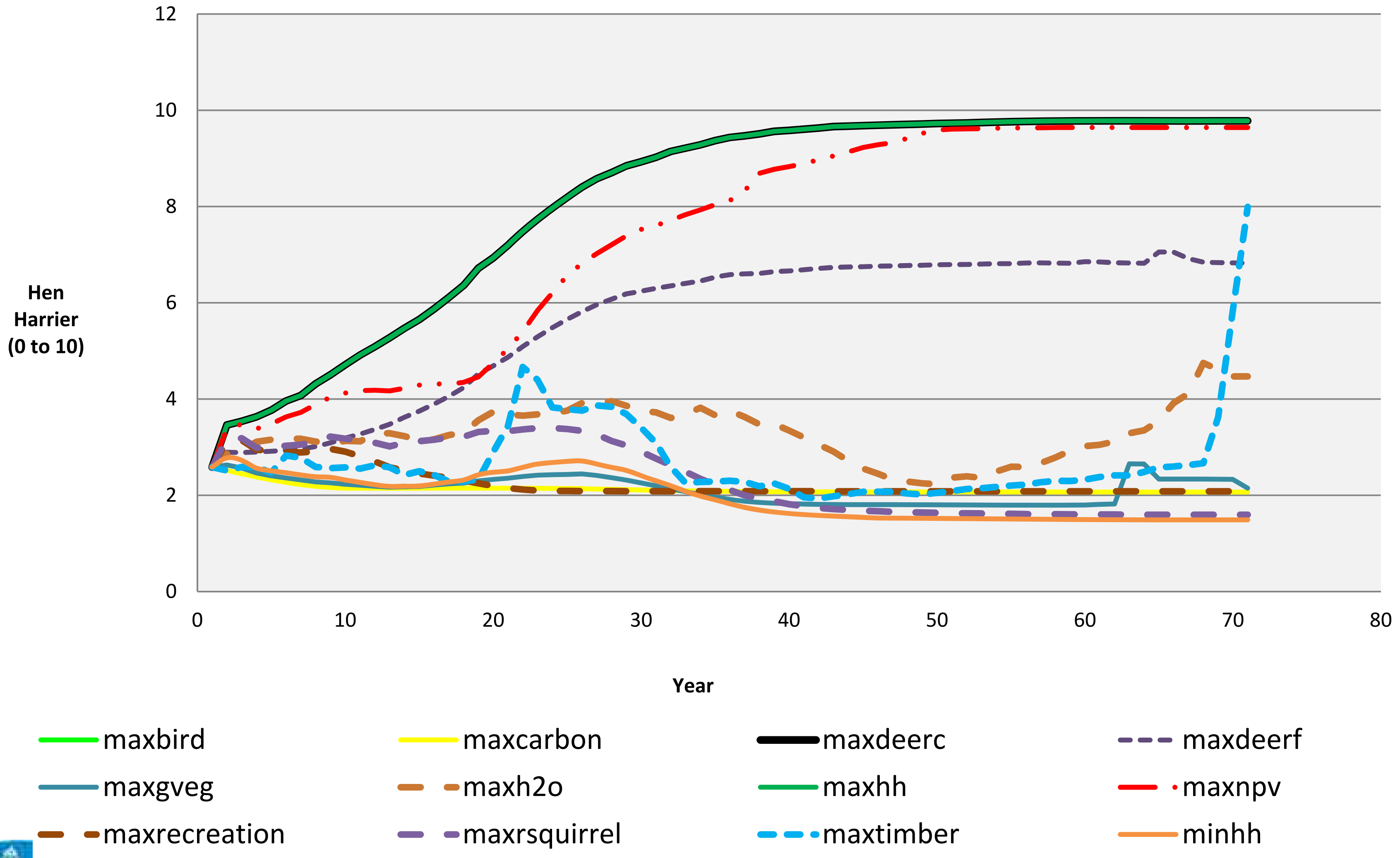
Biophysical model

$$Max \text{ or } Min\ ES_x = \sum_{i=1}^{y} \sum_{j=1}^{n} c_{ij} * X_j$$

Maximise or minimise the total provision level of each ecosystem service separately

ES_x	Units	Abbreviation	
NPV	(€)	NPV	Discounted net revenue at a rate of 5%
Timber	(m^3)	timber	Total harvest volume generated
Deer cover	(1-10)	deerc	Habitat suitability
Deer forage	(1-10)	deerf	Habitat suitability
Hen harrier	(1-10)	hh	Habitat suitability
Water sedimentation risk	(0–100)	h2o	Risk score
Carbon	(M T C)	carbon	Million tonnes of standing carbon
Red squirrel	(1-10)	rsquirrel	Habitat suitability
Nesting birds	(1-10)	bird	Habitat suitability for nesting bird communities
Ground vegetation	(1-10)	gveg	Species richness
Recreation	(1-10)	rec	Relative recreation score incorporating aesthetics and access

Hen harrier habitat in the Western Peatlands CSA



Western Peatlands future scenarios determined by local stakeholders

Scenario	Demand for sawnwood	Demand for pulpwood	Demand for rural development	Water Protection	Replanting requirements	SFM
BAU	Same	Same	No CHP plant in area	Buffer widths stay same	Same	Same
2	Same	Same	No CHP plant in area	Buffer widths stay same	Lifted	Same
3	10% increase in price	10% increase in price	CHP plant in area	Buffer widths stay same	Same	Same
4	10% increase in price	10% increase in price	CHP plant in area	Water related buffer zones doubled 6 km fpm[1] 25 to 50 m Fpm[2] 10 to 20 m	Same	Bog restoration an option. Increased emphasis on ecological ESs
5	Same	Same	No CHP plant in area	Water related buffer zones doubled 6 km fpm 25 to 50 m Fpm 10 to 20 m	Same	Bog restoration an option. Increased emphasis on ecological ESs

[1]Areas within 6 km hydrological distance of a live freshwater pearl mussel site
[2]Fpm = freshwater pearl mussel areas but not within a 6 km fpm zone

Goal Programming model

$$Min \sum_{q=1}^{Q} (n_q + p_q)$$

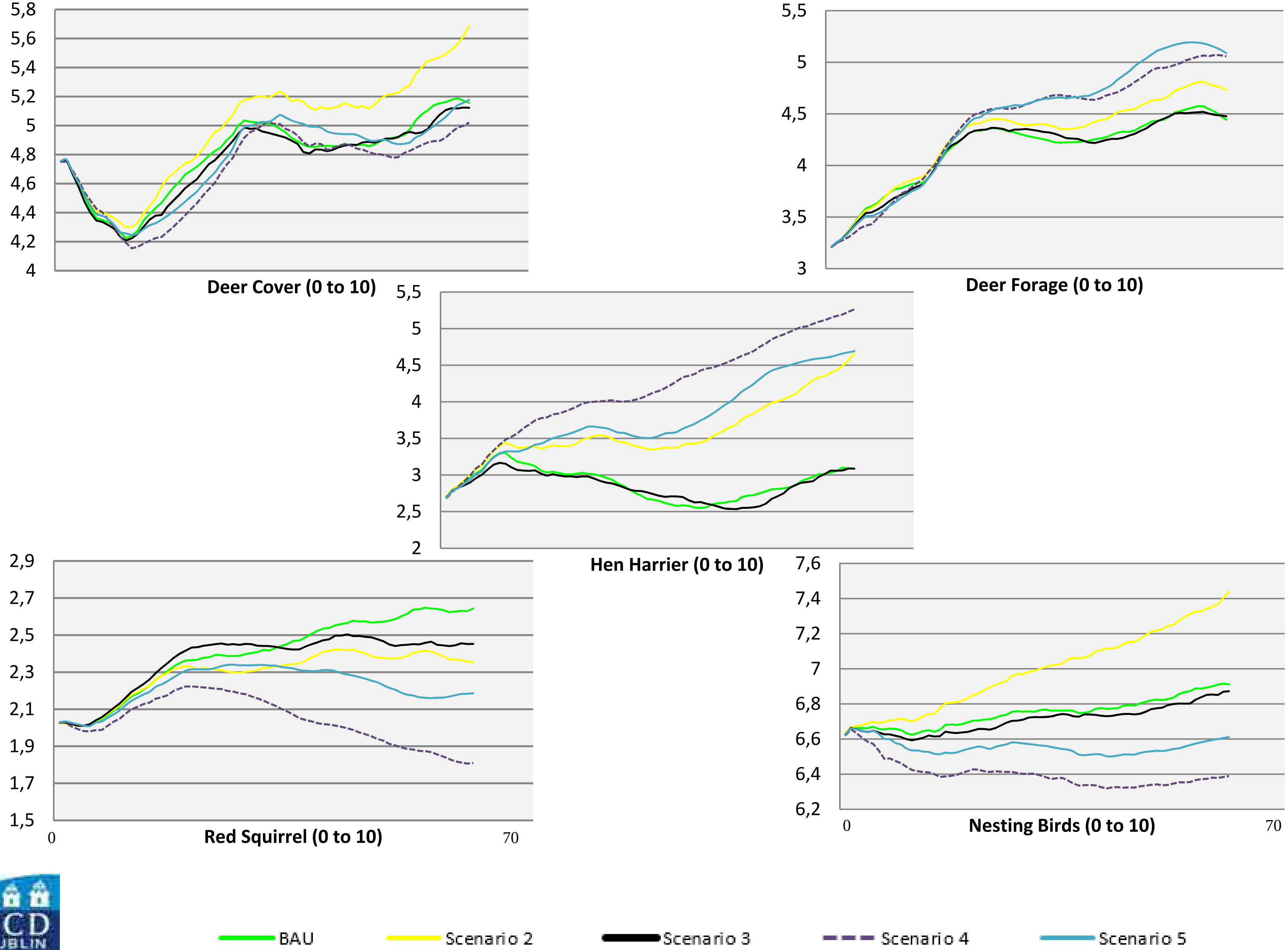
Subject to:

$$f_q(\underline{x}) + (n_q * NW_q * OT_a) - t_q \geq 0$$
$$f_q(\underline{x}) - (p_q * NW_q * OT_a) - t_q \leq 0$$

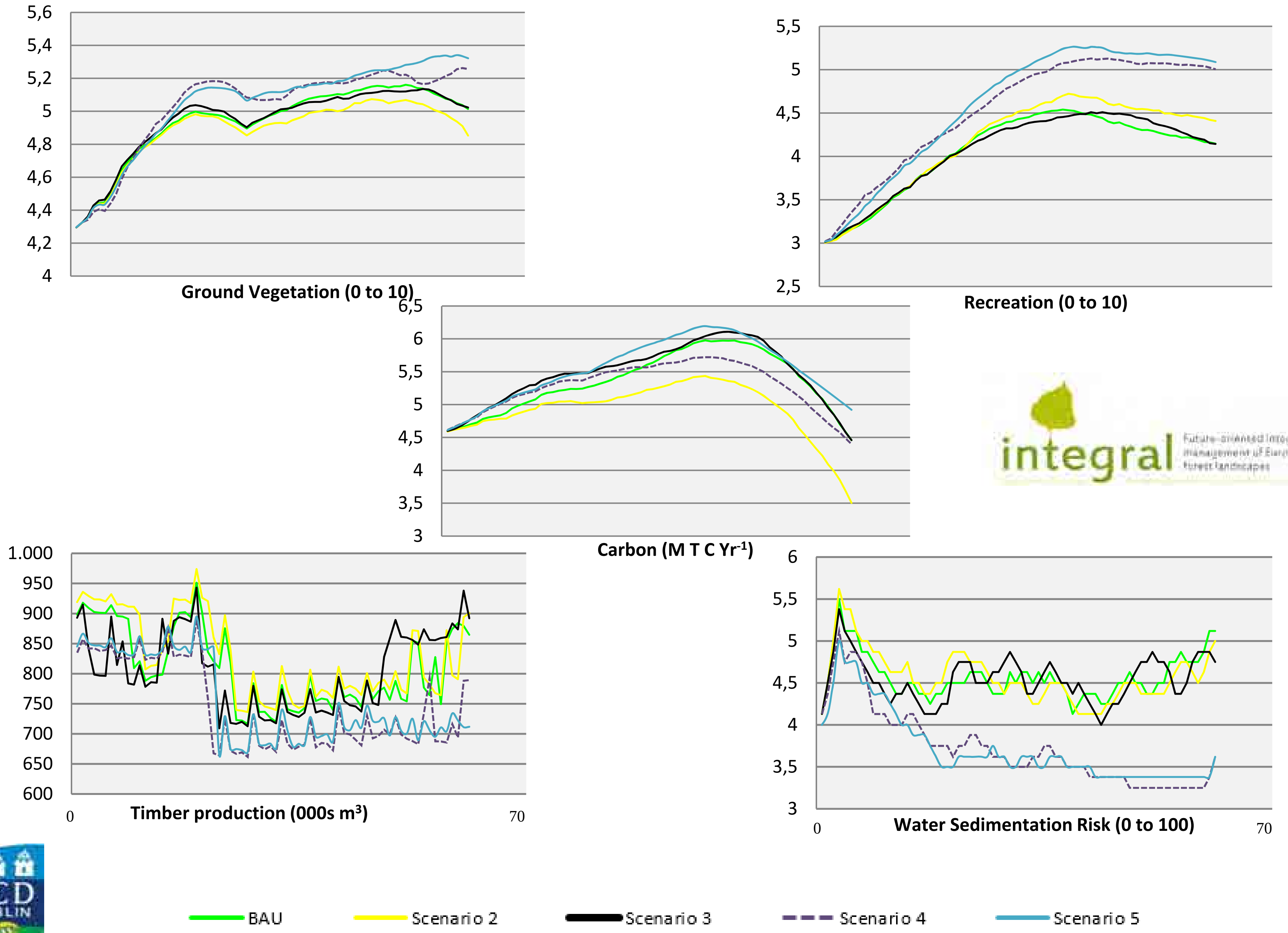
Minimise the sum of the weighted and scaled deviations from the target provision levels for each ecosystem service

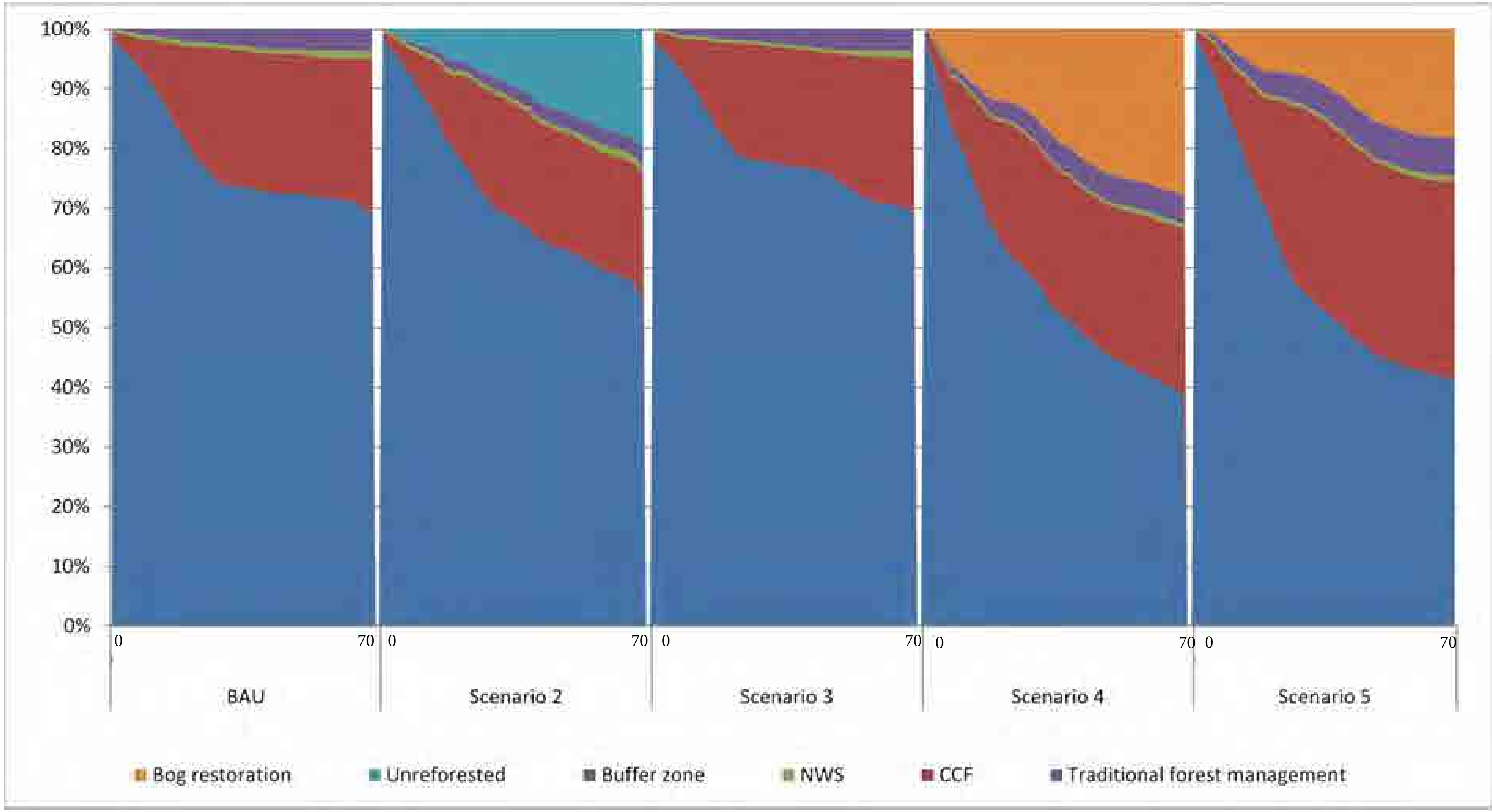
ESs included in the objective function for each WP scenario

Scenario	Deer Cover	Deer Forage	Timber	NPV	Water
1				X	
2				X	
3			X	X	
4	X	X	X	X	X
5	X	X		X	X

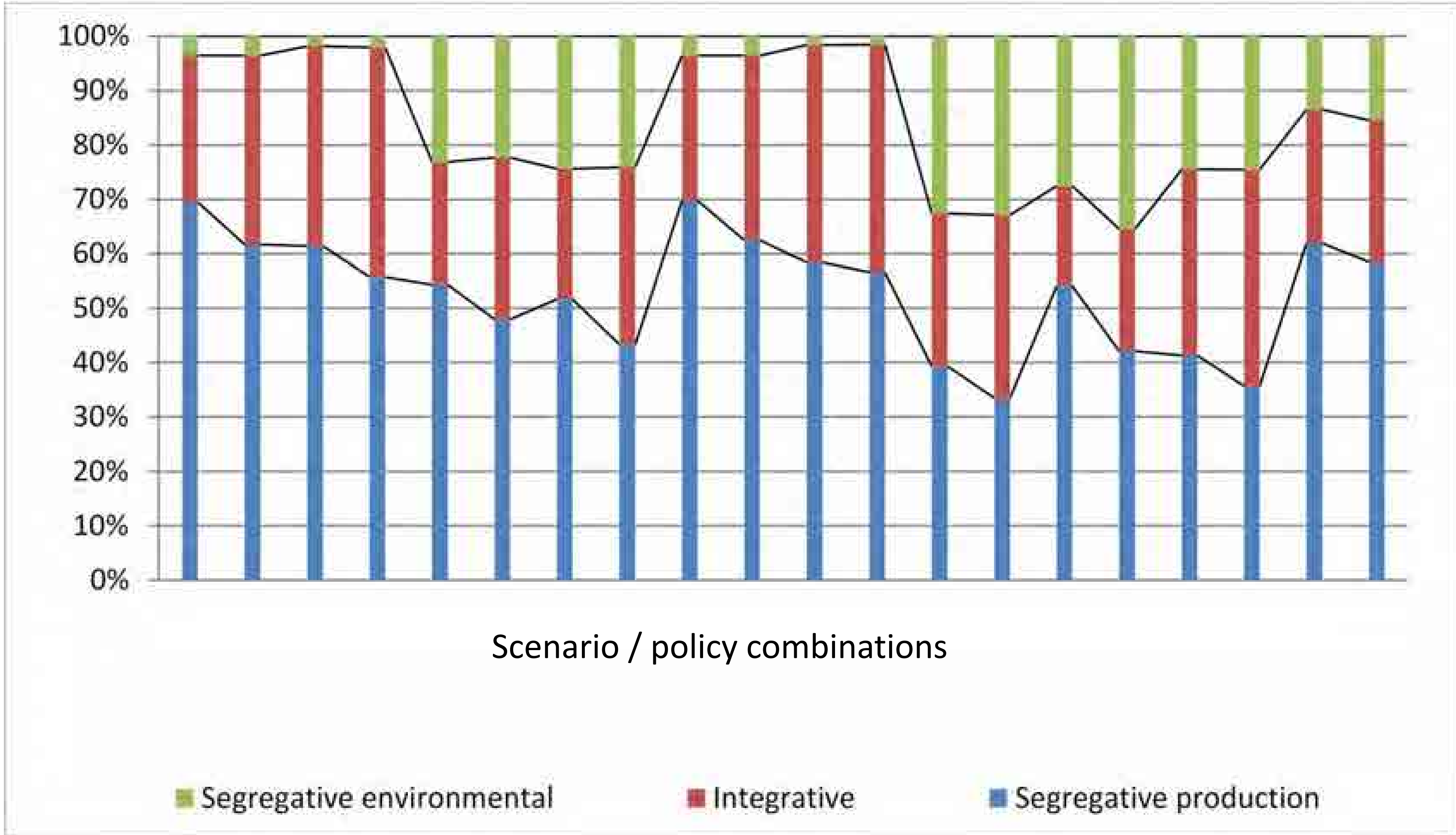


5,8
5,6
5,4
5,2
5
4,8
4,6
4,4
4,2
4
Deer Cover (0 to 10)
5,5
5
4,5
4
3,5
3
Deer Forage (0 to 10)
5,5
5
4,5
4
3,5
3
2,5
2
Hen Harrier (0 to 10)
2,9
2,7
2,5
2,3
2,1
1,9
1,7
1,5
0
Red Squirrel (0 to 10)
70
7,6
7,4
7,2
7
6,8
6,6
6,4
6,2
0
Nesting Birds (0 to 10)
70
BAU
Scenario 2
Scenario 3
Scenario 4
Scenario 5


5,6
5,4
5,2
5
4,8
4,6
4,4
4,2
4
Ground Vegetation (0 to 10)
5,5
5
4,5
4
3,5
3
2,5
Recreation (0 to 10)
6,5
6
5,5
5
4,5
4
3,5
3
Carbon (M T C Yr-1)
1.000
950
900
850
800
750
700
650
600
0
Timber production (000s m³)
70
6
5,5
5
4,5
4
3,5
3
0
Water Sedimentation Risk (0 to 100)
70
BAU
Scenario 2
Scenario 3
Scenario 4
Scenario 5



Management approaches as a proportion of the Western Peatlands CSA forests



The proportions of the Western Peatlands CSA under integrative and segregative management at the end of the planning period, for a wide range of scenario / policy combinations

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integral Future-oriented integrated management of European forest landscapes

ALTERFOR

Alternative models and robust decision-making for future forest management

- Follow-on from INTEGRAL
- Equal numbers of academic and industrial partners
- Inclusion of spatial detail, climate change, harvested wood products and alternative forest management systems in the decision support systems
- Climate change impact will be modelled in Ireland based on ClimAdapt, influencing yield class and species choice

Post-Doc: Dr Edwin Corrigan

PhD student: Anders Lundholm

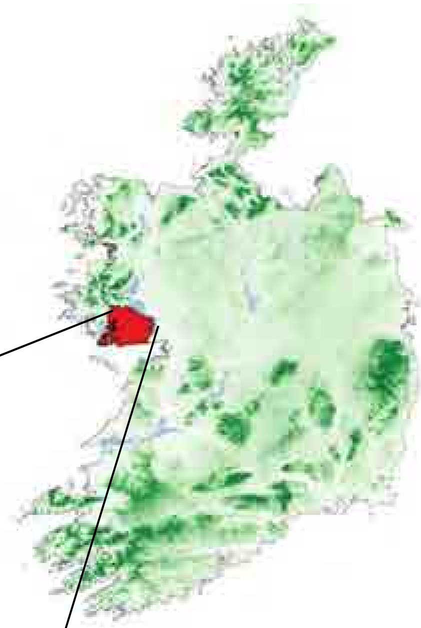
Horizon 2020 Programme

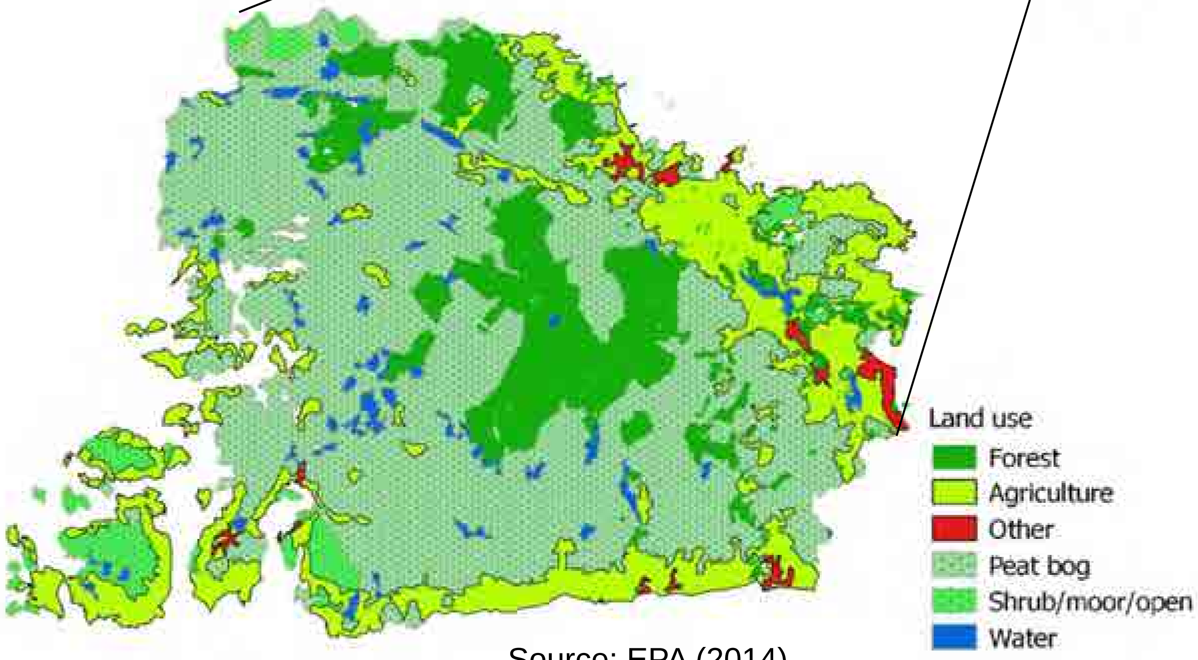
ALTERFOR

Description of the CSA - The barony of Moycullen

Population (CSO - Census 2011)	22,344
Area	81,853 ha
Forest	12,835 ha
Forest cover	15.7%
Forest ownership – Public	77.6%
Forest ownership – Private	21.7%

- National and international tourism
- 8 SACs, SPAs and NHAs
- Recreation
- Windfarms





Source: EPA (2014)

FASTFORESTS

The potential impact of forest intensification on forest productivity and wood mobilisation under different climate change scenarios

WP 2:

- Analyse Sitka spruce (SS) forest productivity in Ireland under alternative silviculture and forest management systems
- Assess SS suitability and productivity under different climate change scenarios
- Assess the mobilisation of wood resources at the national level

Masters student: Alba Cabrera Berned

This research is funded by the Department of Agriculture, Food and the Marine

Effect of forest management: Growfor

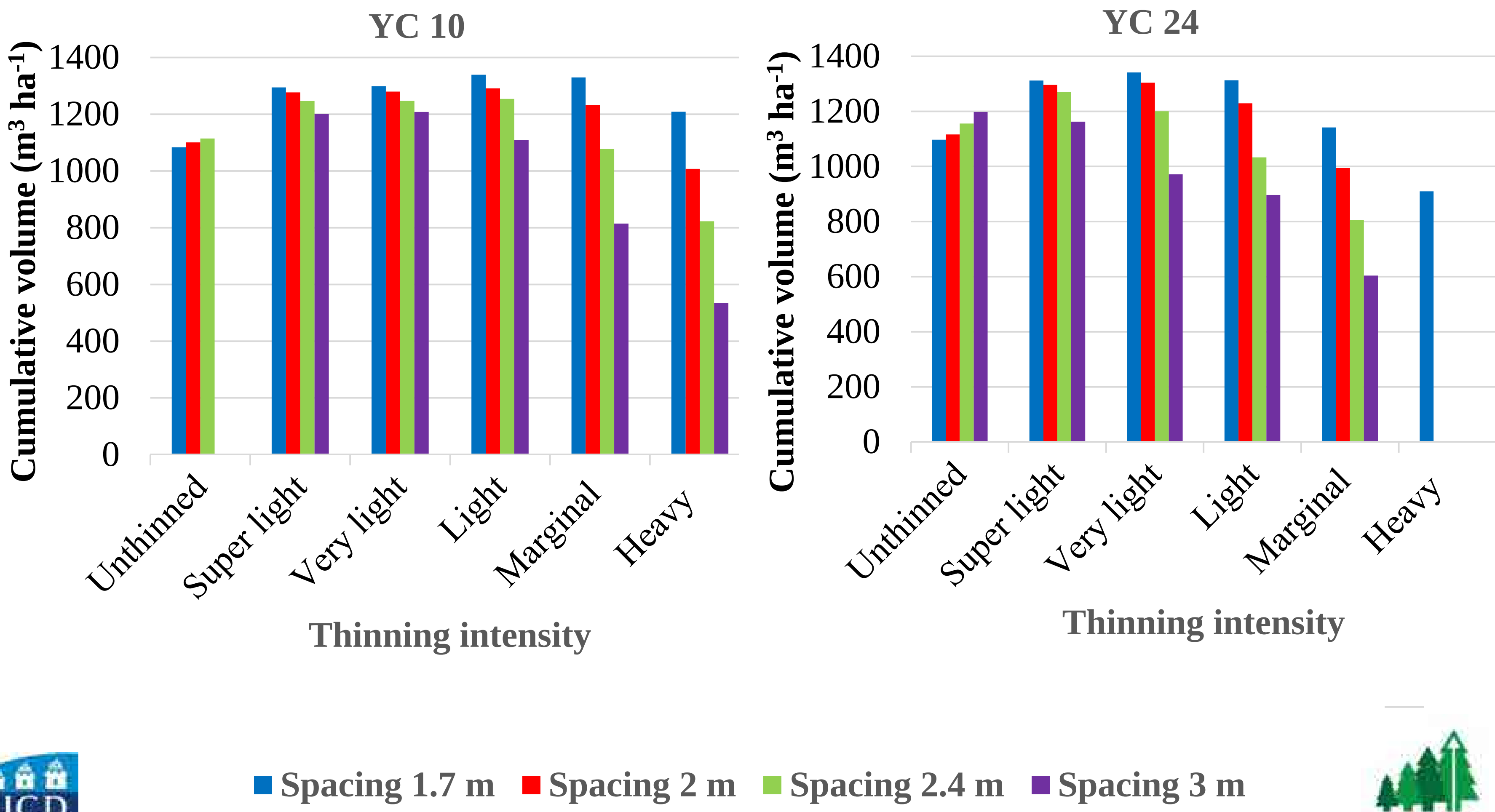
- Sitka spruce
- YC 10 to 24
- 5 year thinning cycle

Forest management regimes considered in the study:

Management variables	Thinning intensity	No thinning
		Marginal – MTI (i.e. 70% of MMAI)
		Light (80% MTI)
		Very Light (70% MTI)
		Super Light (60% MTI)
		Heavy (120% MTI)
	Square spacing between trees (m)	1.7
		2.0
		2.4
		3.0

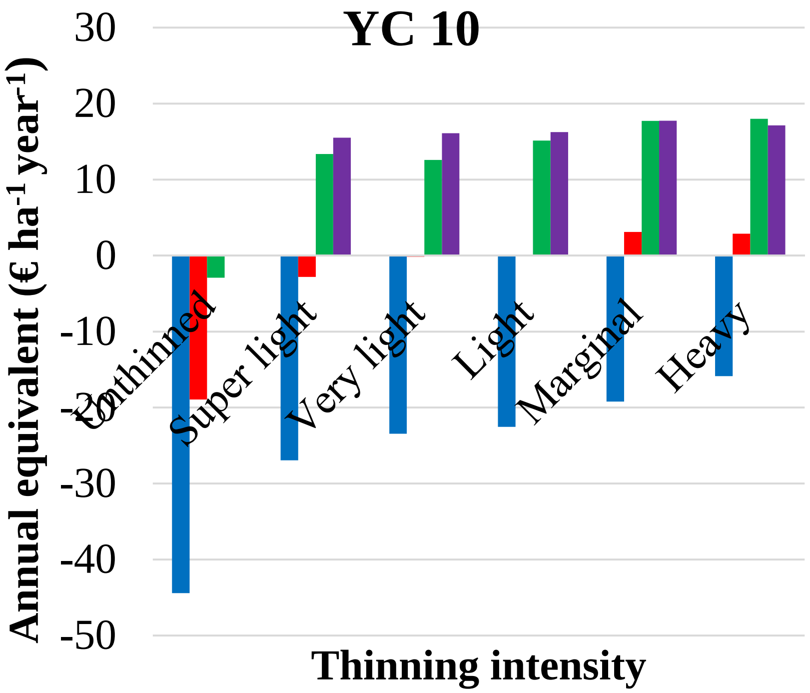
Effect of forest management

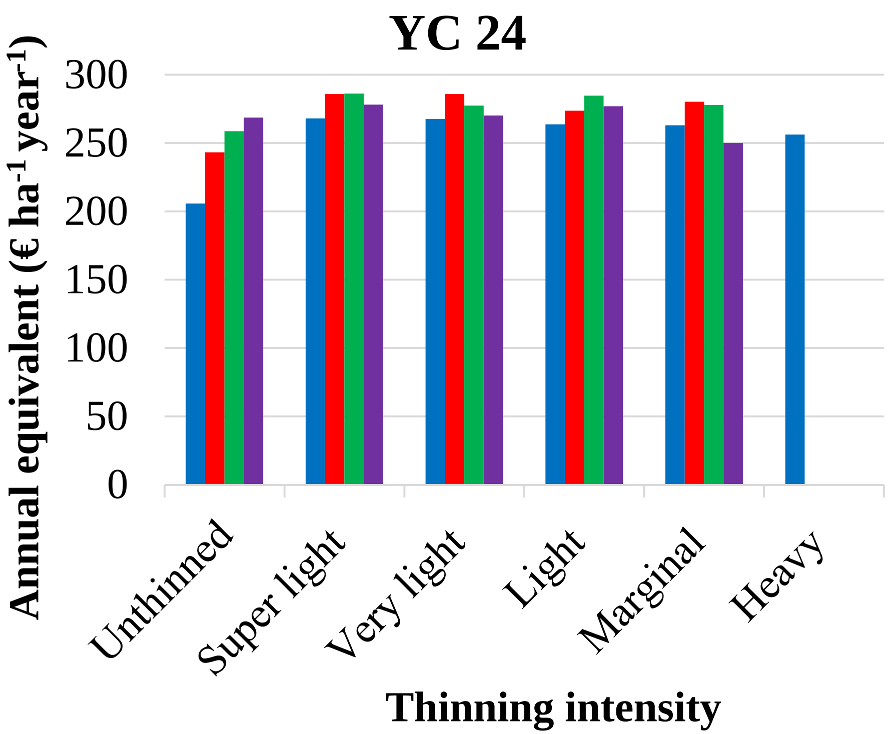
a) Greatest volume production



Effect of forest management

b) Greatest net income based on average tree size





■ Spacing 1.7 m ■ Spacing 2 m ■ Spacing 2.4 m ■ Spacing 3 m

Effect of climate change: ClimAdapt

ESC →To assess SS suitability and yield

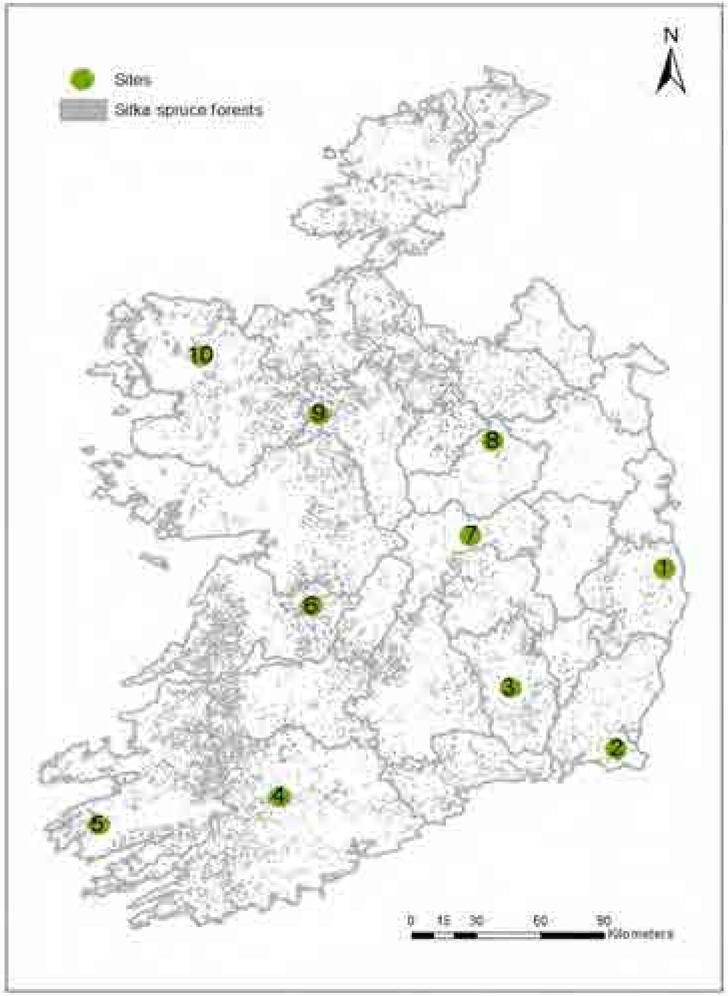
4 Climatic factors

2 Soil quality factors

10 sites

System's default soil characteristics
+
Climate change scenarios:
Baseline, 2050 A2, 2050 B1 and 2080 A2

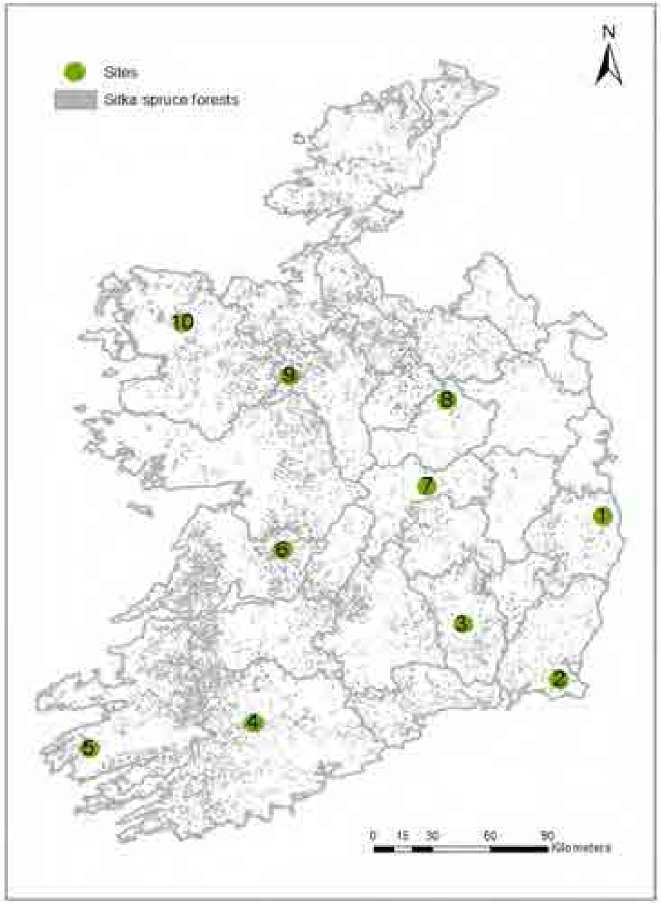
Very suitable, suitable or not suitable
&
Indicative yield class



Effect of climate change

Site	YC			
	Baseline	2050 A2	2050 B1	2080 A2
1	22	23	23	22
2	12	9	12	6
3	15	13	6	9
4	20	16	19	16
5	21	23	23	25
6	21	15	17	12
7	18	17	19	15
8	19	19	21	18
9	21	21	22	21
10	22	9	8	10

Very suitable (YC ≥ 20)
Suitable (YC 10 - 20)
Unsuitable (YC ≤ 10)



- SS productive in the majority of the country by the middle and end of the century
- Greatest warming in south-east Ireland (sites 2 and 3)

Main limiting factors:
MD & SMR

SIMWOOD

Sustainable Innovative Mobilisation of Wood

- **Substantial increase of demand**
  - Timber: 853 million m^3 in 2030
  - Woodfuel: growth > 1.5% per year, 585 million m^3 in 2030
- **Under-utilised wood resources**
  - Current harvesting levels below sustainable allowable cut
  - Theoretical potential very high, ‘mobilisable’ potential still unknown
  - Main potentials `locked´ in private forests

- **Novel solutions for wood mobilisation**

- Understanding the motivations that influence forest owners’ decisions
- Viable, market-oriented solutions are the priority
- Grouping, collaboration, economies of scale, risk sharing mechanisms
- Improved knowledge transfer to different target groups
- Adaptive silviculture
- Monitoring systems for multiple forest functions

Pilot project

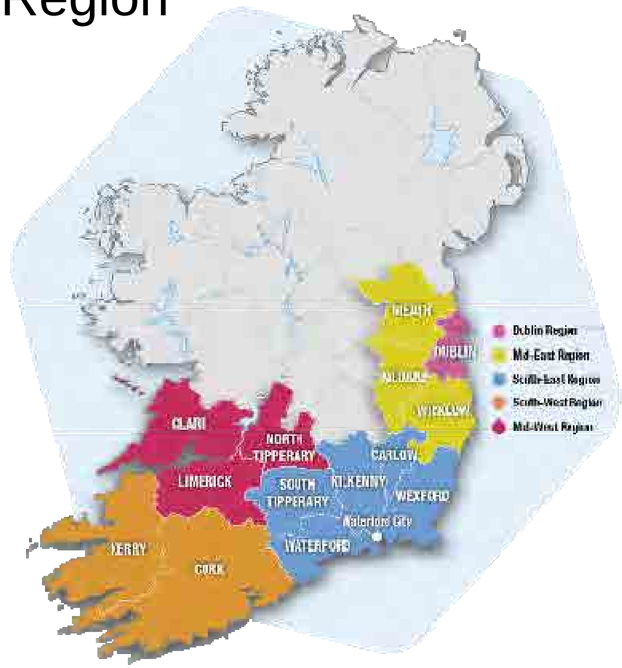
The research questions are:

- In which forests of the study region is it **operationally feasible** to commercialise residual biomass as part of first thinnings?
- In which of these forests is it **economically viable** to commercialise residual biomass as part of first thinnings?
- Develop a decision support system

Case study area: Southern and Eastern NUTS-II Region

(Nomenclature of Territorial Units for Statistics)

Masters student: Eva Ardao Rivera



SIMWOOD

Sustainable Innovative Mobilisation of Wood

(1) Suitability analysis

1.1. Are the **trees old/large** enough so that the forest can be thinned?

Wait if they are not old enough; thinning not recommended if trees are younger than c.a. 13 years ← NO

YES ↓

1.2. Is the **quality** of the trees suitable to be thinned for **conventional wood products**?

Analyse whether extracting the wood biomass for energy generation could be feasible ← NO

YES ↓

1.3. Would the **soils** sustainably endure if residual above ground biomass is extracted?*

May carry out first thinning under conventional harvesting operations if possible ← NO

YES ↓

1.4. Is the forest located at a feasible **distance from** any potential **biomass-user**?

Carry on conventional practices and reconsider the model if new end-users are established ← NO

YES ↓

→ *Consider requirements and capacity of the potential end users*

1.5. Is the **quality** of the trees suitable for harvesting their **residual above ground biomass**?

Carry out first thinning under conventional harvesting ← NO

YES

(2 & 3) Viability assessment

(2) Forest products' value

2. What is the **value of the residual above ground biomass**?

(3) Costs of exploitation

3.1. What are the ***conventional* costs** (harvesting, forwarding, chipping…)?

3.2. How does the **soil type** affect the extraction volumes – costs of harvesting *sustainably*?

3.2. What are the costs of **transporting** the products to the **end user**?

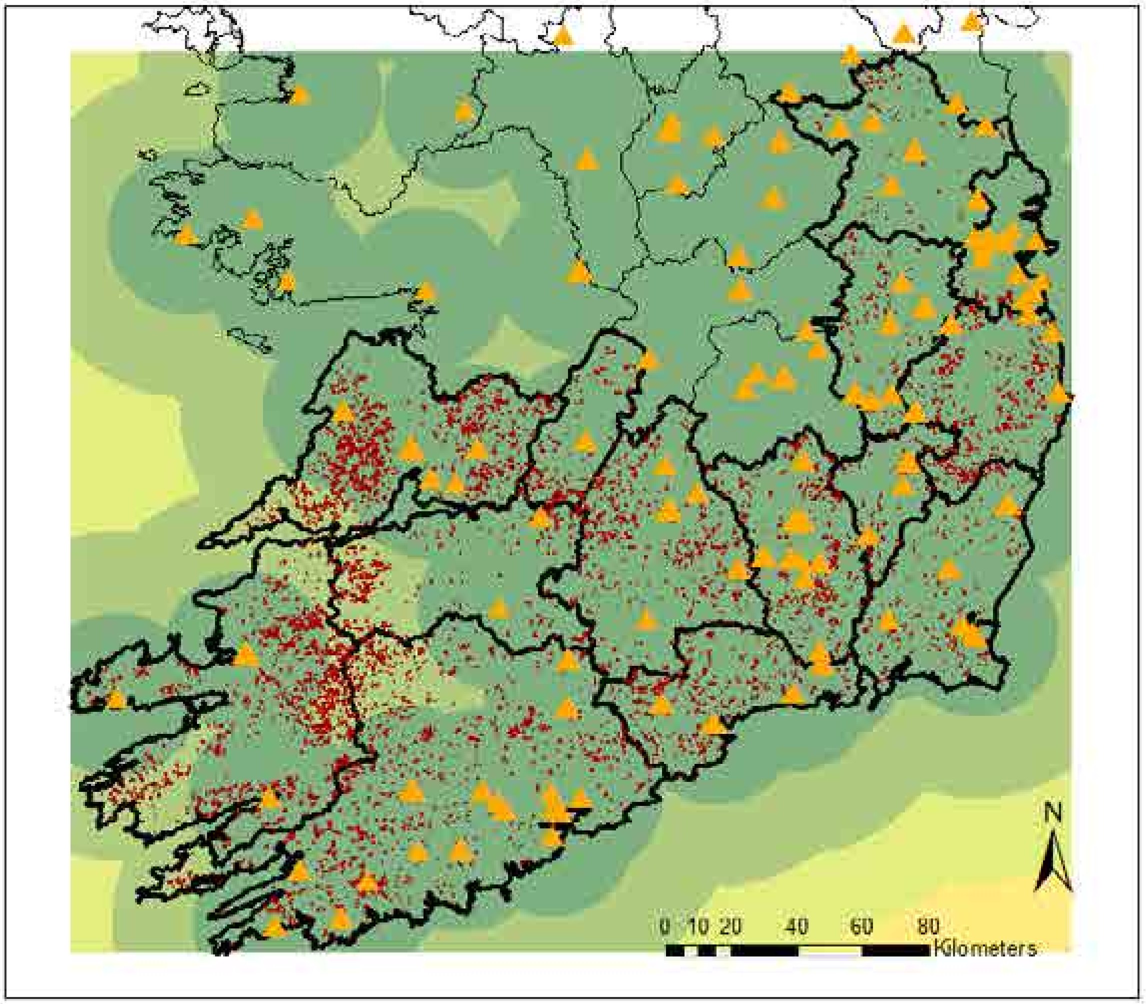
3.3. How does the **access to the forest** and **infrastructure in the forest** influence the costs?

3.4. What are the costs related to **stocking space** and **drying material**?

Profit from biomass

Economically viable

Not economically viable



Distance to ReHeat Biomass End Users

Reheat Biomass Users

Forests plantations of commercial species suitable for undergoing 1st thinnings

SIMWOOD Region Countries

Distance to Industrial Biomass Users (kilometers)

0 - 25

25 - 50

50 - 75

75 - 100

100 - 125

125 - 150

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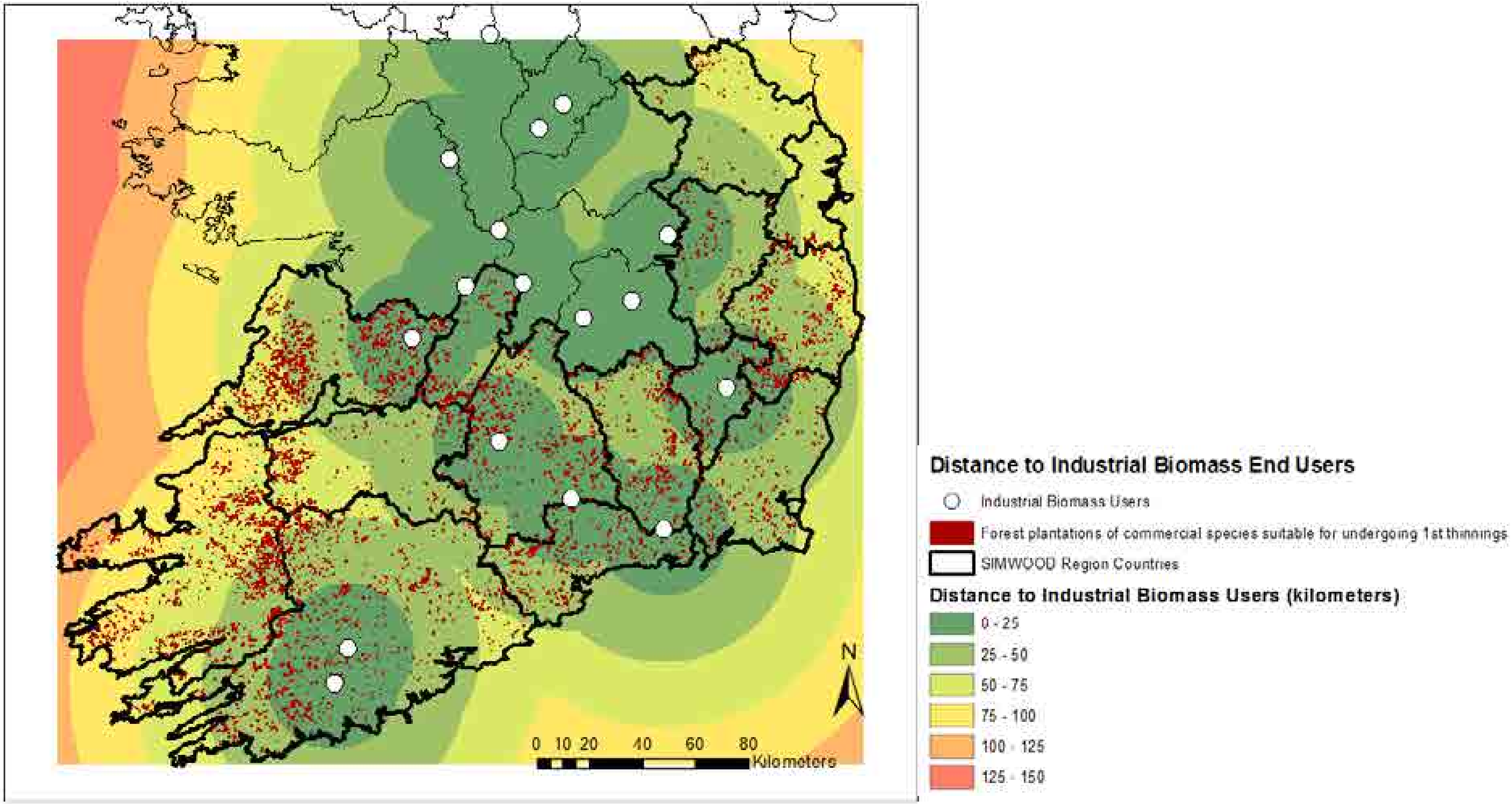
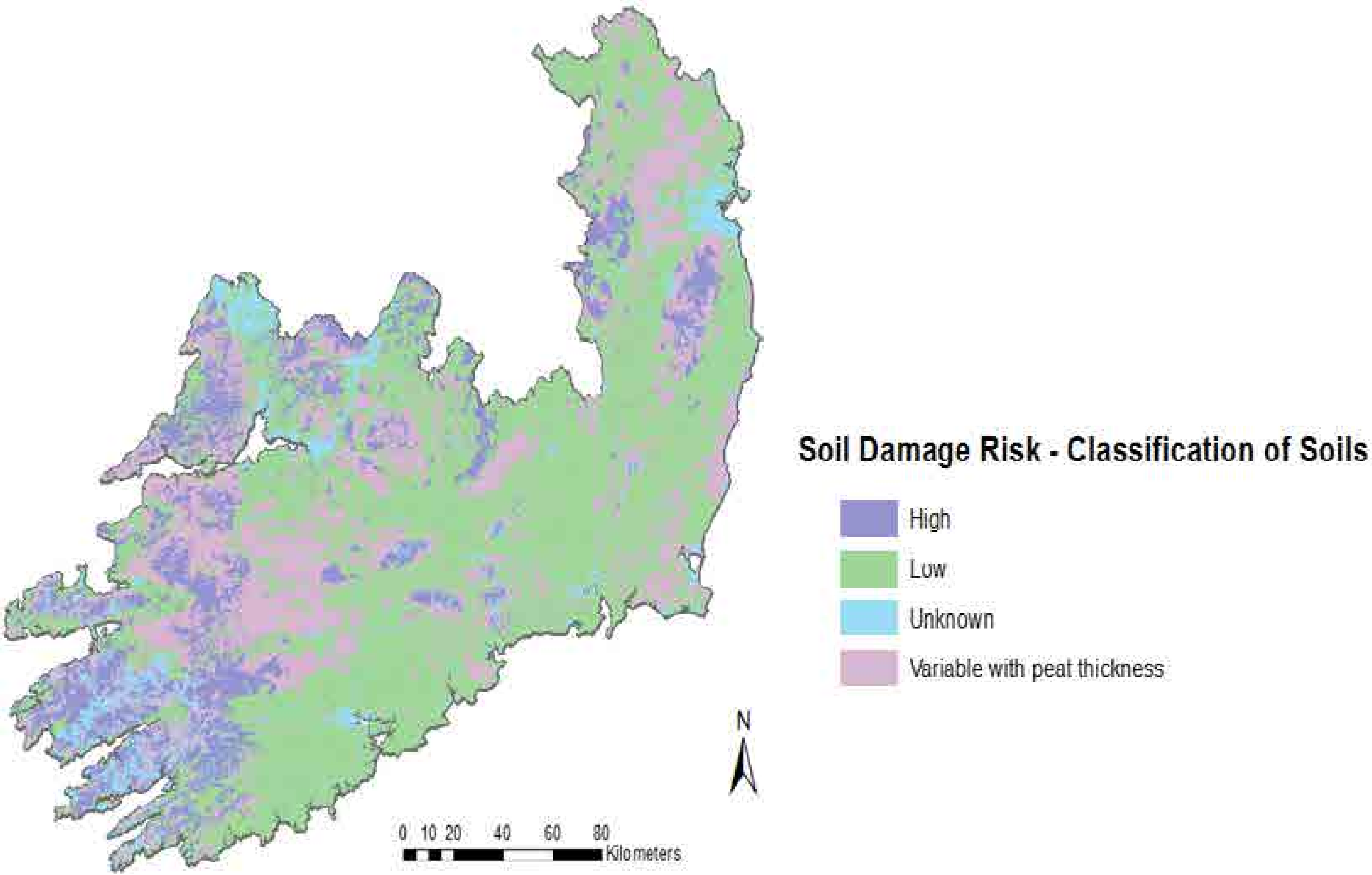
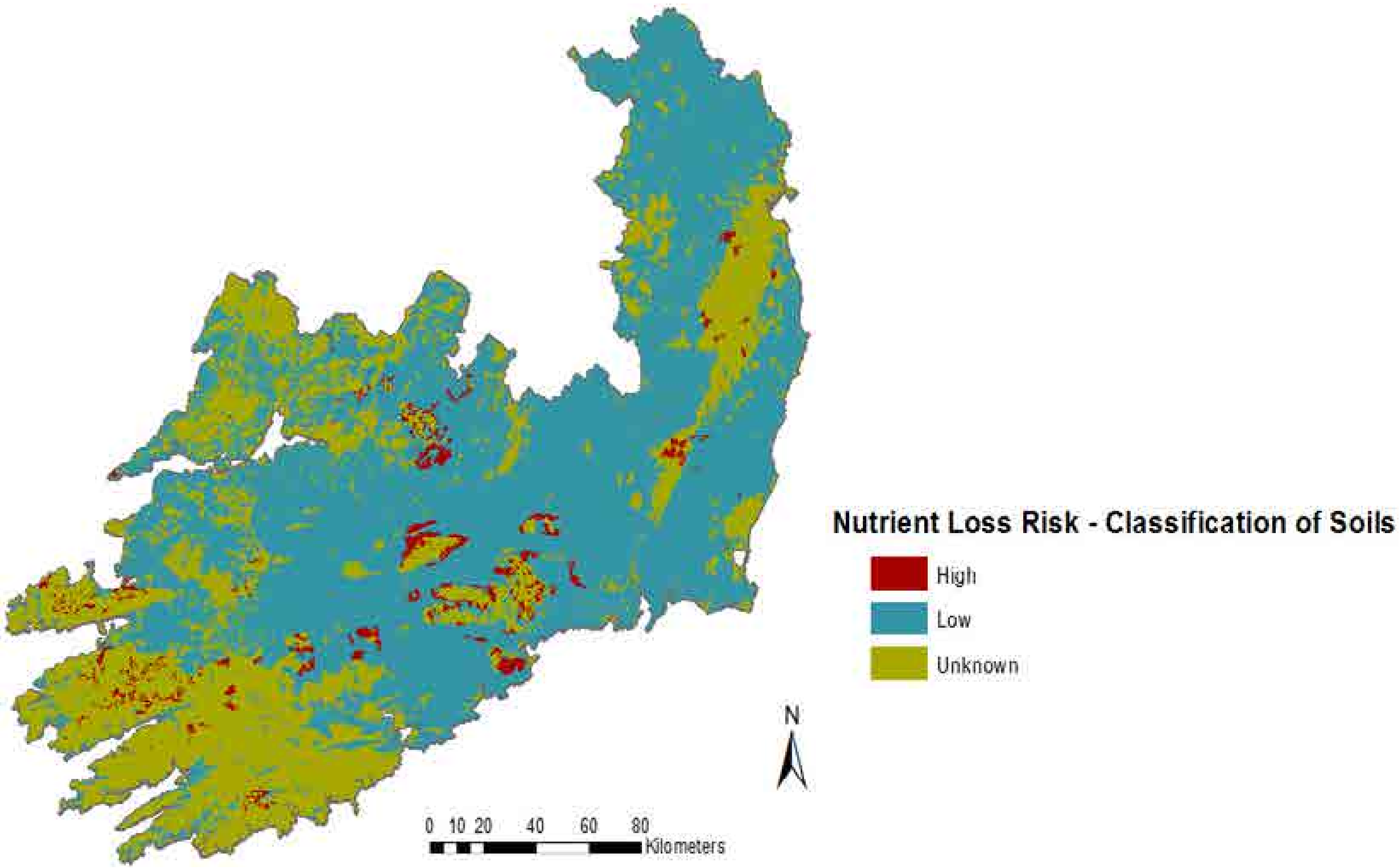
SIMWOOD
Sustainable Innovative Mobilisation of Wood


Distance to Industrial Biomass End Users
Industrial Biomass Users
Forest plantations of commercial species suitable for undergoing 1st thinnings
SIMWOOD Region Countries
Distance to Industrial Biomass Users (kilometers)
0 - 25
25 - 50
50 - 75
75 - 100
100 - 125
125 - 150
N
0 10 20 40 60 80
Kilometers


Soil Damage Risk - Classification of Soils
High
Low
Unknown
Variable with peat thickness
N
0 10 20 40 60 80
Kilometers



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SIMWOOD
Sustainable Innovative Mobilisation of Wood

Estimated volumes of residual aboveground biomass that has to be left on site when considering the conditions of the soil

Soil suitability	Correction factor	Percentage of residual aboveground biomass left on site
Extremely fragile ground conditions	**0.0**	**100%**
Very fragile ground conditions	**0.2**	**80%**
Fragile ground conditions	**0.4**	**60%**
Normal ground conditions	**0.6**	**40%**
Strong ground conditions	**0.8**	**20%**
Very strong conditions	**1.0**	**0%**

Concluding remarks

- No ‘one size fits all’ forest management: localised, adaptive management with risk and markets incorporated in the planning process
- Importance of recognising owner types and the potential for alternative management approaches
- Landscape level planning allows for the inclusion of ecosystem services
- Society needs to decide what state and private forests should contribute, in terms of ecosystem services, to the national well-being in the future
- Is the production of bioenergy from forests the best use of these ecosystems or should the raw material be used (first) in other applications, i.e. cascade use?
- Interactions between changing climate, markets and societal demands make the sustainable management of forests a complex but very exciting area of research

Thank you

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