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Vulnerability Assessment for Wales

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This report was compiled by students during the AVEC Summer School 2003 as a case study

Contents

1 Introduction

The objective of this study is to perform a vulnerability assessment to inform the decision-makers of Wales of the potential vulnerability of Welsh ecosystem services to global environmental change.

In our vulnerability assessment of Wales, we chose the following approach:

1. identify the important sectors (depending on ecosystem services) for Wales.
2. identify stakeholders and have a stakeholder dialogue.
3. identify the important services in the different sectors (based on the stakeholder dialogue).
4. downscale the Special Report on Emission Scenarios (SRES) scenarios for Europe (Rounsevell, pers. comm. 2003) to the scale of Wales and write story-lines.
5. identify useful indicators for the different services and their sensitivity to various drivers.
6. assess the impact of different scenarios on the services on a regional scale (upland, lowland, urban and coastal).
7. assess the adaptive capacity of Wales on a national and regional scale.

2 Study area: Wales

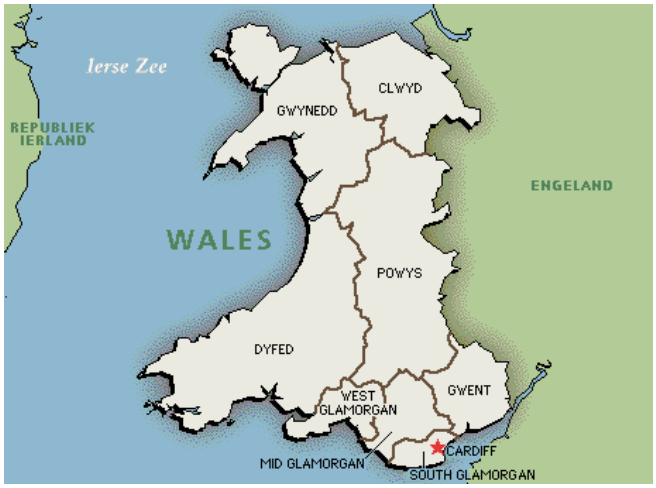

Fig. 1: County map of Wales.

The total area of Wales is 22,000 km^2. It is divided into nine counties (Fig. 1). The population of Wales is 2,903,089 (UK Census 2001), i.e. 4.9% of the United Kingdom population. 67% of the population identify themselves as Welsh and 21% are Welsh speakers. Welsh culture is celebrated in Eisteddfods, where competitions are held in a range of cultural activities including dance, music and poetry. The National Eisteddfod for Wales is one of Europe largest cultural competitions, and is believed to have begun in South Wales in 1176 AD. The Eisteddfods play an important role in Welsh life by promoting the Welsh language and the arts.

The Welsh economy has changed in the last 30 years from heavy industries (coal and steel) to a broader range of manufacturing and services. The Welsh economy performs relatively poorly compared to other UK regions: incomes are low and unemployment is high. The gross domestic product (GDP) of Wales per capita is 80% of the UK average (the 1997-2001 average GDP per capita was £10,618; for further information on Welsh economic statistics visit http://www.statswales.wales.gov.uk or the Welsh Assembly web site http://www.wales.gov.uk). The sectors that are relatively more important in Wales than in the UK as a whole are (in decreasing order of job numbers): manufacturing, health and social work, public administration, hotels and restaurants, agriculture (including hunting, forestry and fishing) and mining and quarrying (except for coal).

Wales has a very high proportion of land and coast with some degree of environmental protection. It has three national parks (Snowdonia, the Brecon Beacons and Pembrokeshire) and a higher density of Sites of Special Scientific Interest (SSSIs) than England; its upland ecology is important and particularly sensitive. Its coastline is long in relation to its area and its population and tourism are concentrated on the coast (Farrar, 2000). Fig. 1 and 2 show the main land use/cover for Wales.

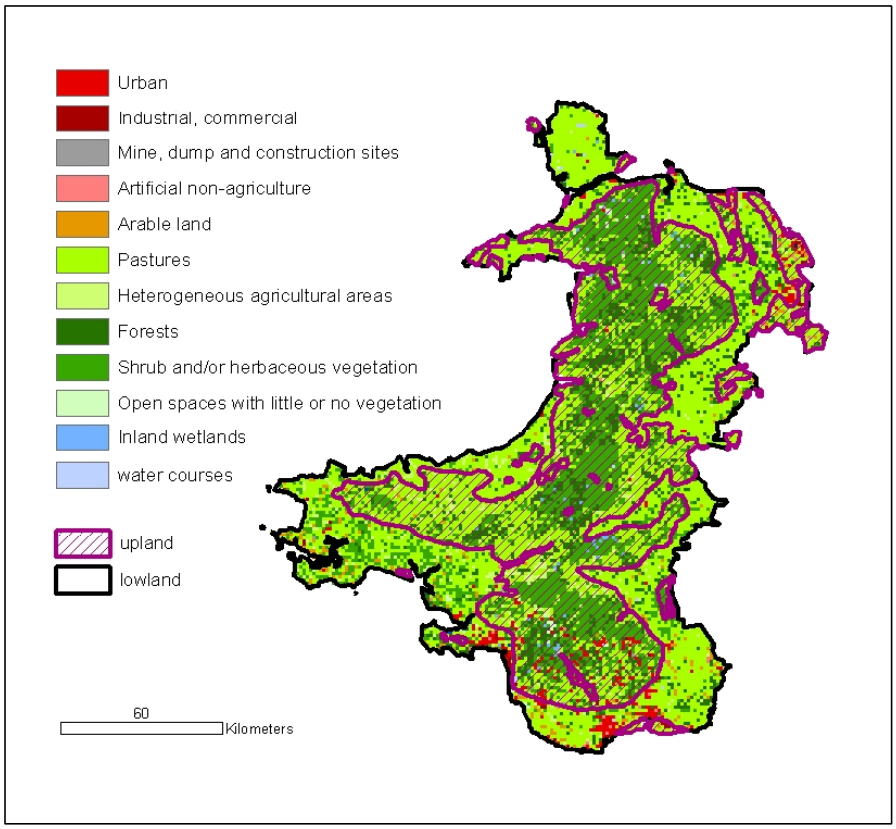

Fig.2: Land-use map of Wales.

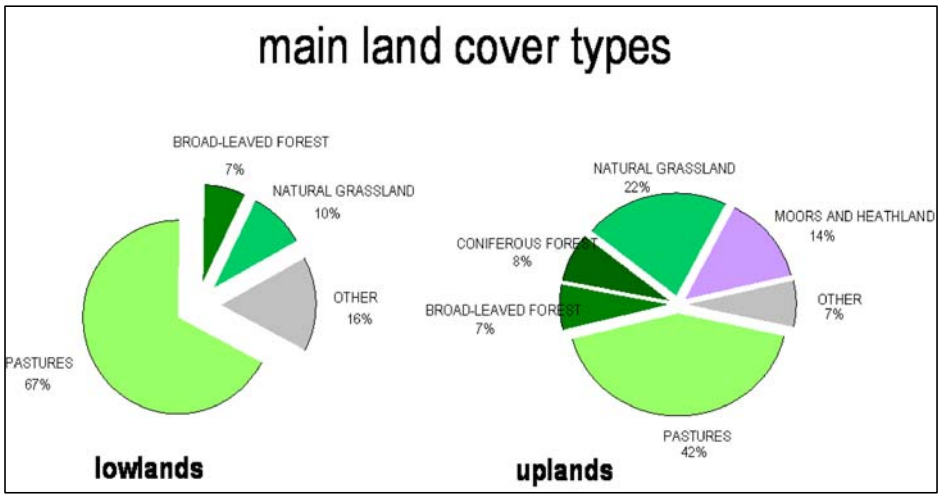

Fig.3: Percentage of land-use area for the lowlands and uplands

Wales is one of the poorer regions of Europe; West Wales & The Valleys have been designated as Objective One regions. Objective One is the highest priority designation for European aid and is targeted at areas where prosperity, measured in GDP per head of

population, is 75% or less of the European average. The other regions of the UK currently designated as Objective One areas are: Cornwall and Scilly, South Yorkshire and Merseyside. Including the UK, there are currently a total of 57 regions within EU member states with Objective One status. These regions include the whole of East Germany, all of Greece, much of Spain, some of France's remote overseas territories, southern Italy and Sardinia, part of Eire, a region in Eastern Austria, most of Portugal, and northern parts of Finland and Sweden (www.objectiveone.com/ob1/html/guide/step1z1.html).

Wales was selected as a region for a vulnerability assessment due to its relative autonomy and because the United Kingdom Climate Impacts Programme (UKCIP) scoping study (Farrar, 2000) recommended that "socio-economic scenarios need to be developed for Wales taking account of the regional economic statistics to provide a more detailed picture of how the interaction of climate change and socio-economic scenarios might impact on Wales." Furthermore, Wales is not one of the regions covered in the regional climate change impact and response study (REGIS).

3 Identification of sectors, stakeholders and ecosystem services

The most important sectors for Wales were considered to be the land-use sectors (such as agriculture, forestry and nature conservation). Other sectors considered to be important were: tourism, the water sector (including flood protection), the marine sector (including fisheries and flooding caused by sea-level rise) and the industry and energy sector (Table 1). Stakeholders representing the different sectors were chosen and invited for a stakeholder meeting, during which the important ecosystem services were identified.

Table 1: The important sectors, their stakeholders and the important ecosystem services.

Sector	Stakeholders	Ecosystem Service
agriculture	farmers Welsh Assembly	dairy / meat / wool production profit
forestry	forestry commission private landowners	timber production C-sequestration
nature conservation	Countryside Council for Wales Environment Agency Tourist Board	biodiversity landscape diversity cultural heritage
water	Environment Agency Welsh Assembly Environment Dept.	drinking water flooding
marine	fisheries Welsh Assembly	fisheries flood protection
tourism	Tourist Board National Trust Environment Agency	cultural heritage natural heritage coastal tourism river tourism
industry / energy	manufacturing companies employers' associations Energy Board Welsh Assembly	wind power hydropower

4 Downscaling of the SRES scenarios for Wales

In this study we used the downscaling of the SRES scenarios for Europe made by Rounsevell (2003). These were then further downscaled to the regional level of Wales, taking into account the local political, economic, social and environmental features of Wales through dialogue with the stakeholders. This was done by considering the likelihood of similar trends being observed in Wales to those predicted across Europe. A large positive correlation between the predictions for Wales and the European Union (EU) was graded as ++, a small correlation as +, no change as 0, a minor divergence from the EU predictions as - and a large divergence as -- (Table 2). In association with these symbols, story-lines were written, describing the different SRES scenarios for Wales.

Table 2: The European SRES scenarios (Rounsevell, pers. comm. 2003) and their downscaling for Wales. ++ indicates a large correlation, + a small correlation, 0 no change, - a minor divergence and -- a large divergence.

EU	A1-EU	A1 Wales	A2-EU	A2 Wales
Economy-GDP	rapid growth, convergence	++	growth, uneven	-
population	decline	--	growing	+
technological change	rapid	+	slow and uneven	0
institutions and government	weak	--	weak, diverse	--
rural development	not a focus area	--	result of self-reliance	-
recreation, tourism	increase	+	increase, decrease resp.	-
spatial planning	convergent, less restrictive	--	heterogeneous	-
EU enlargement	rapid	--	slow and uneven	+
EU	**B1-EU**	**B1 Wales**	**B2-EU**	**B2 Wales**
Economy-GDP	growth, convergence	+	slow growth, uneven	0
population	declining	--	stable	0
technological change	rapid	+	uneven	0
institutions and government	strong	++	weak, except local	++
rural development	key issues	++	increase (self-reliance)	+
recreation, tourism	increase, decrease resp.	++	increase, decrease resp.	0
spatial planning	convergent, restrictive	++	heterogeneous, restrictive	++
EU enlargement	moderate	0	stopped	++

Welsh Story-lines for SRES scenarios

A1 – Pob-ty-ping

As the world becomes more globalised, the population growth in Wales decreases but there is an increase in urban sprawl in the south of the country. Infrastructure and transport become more congested as people move from rural areas to the cities in the south. Rural areas in mid and north Wales are abandoned and the average age of these communities increases. Some rural and coastal communities still survive, but consist predominantly of second homes. Agricultural areas are abandoned as European subsidies for farming are drastically reduced or stopped. Some people remain in the rural areas, but only through diversifying away from farming. Nature conservation still continues, but protected areas are increasingly marginalised and people rely more and more on technologies for quick fixes of environmental problems.

New technology increases the efficiency of many of the industries of Wales; this allows greater profits and wages go up. Although the housing sector and the cost of housing increase, people are better-off and have more leisure time. Increasingly, holidays become more and more international and this results in a greater influence of other cultures on Welsh culture.

People feel more European than Welsh and the Welsh language dies out. Cultural celebrations, including eisteddfods, are be replaced by diverse festivals celebrating world culture, science and new technology.

In the A1 Wales, the divide between the north and the south of the country remains, as people migrate from the north and midlands to the south. A similar migration is seen away from rural areas into increasingly widespread urban areas. People have more money, but at the expense of the rich cultural heritage the country currently has.

A2 – Decline

The economic position of Wales suffers in an increasingly regionalised and economically dominated world. The impact is variable across the country, with the south less affected than mid and north Wales. Industry in the south continues; however, there is little change from the manufacturing of the present day. The gap between the economies of England and Wales also widens as GDP falls and the economy slows down.

In rural areas unemployment rises as land is abandoned and the tourist industry declines. The general pressure on social security benefits and the national health service increases. With rising unemployment, towns and villages in mid and north Wales become derelict and crime increases. Crime spreads into the southern cities as people abandon the rural areas in hope of a better life. There is also an increasing gap between rich and poor.

Rural areas near cities fill with commuters. However, land in mid and north Wales is abandoned. Areas protected for nature conservation are increasingly neglected and, along with the abandonment of agricultural land, mid and north Wales returns to wilderness: moorland (hills) or forest (lowlands). The rate of change depends on the proximity of seed sources and the biology of the species involved – bracken can overrun a pasture in a few years, while trees require several decades. The few communities that remain in mid and north Wales become increasingly nationalistic and terror attacks on non-Welsh people increase. The Welsh language and eisteddfods thrive, as do other cultural events promoting Welsh culture.

B1 – Woollywood

Tourism becomes global and Wales becomes an environmental and rural destination. The "Authentic Rural Experience" is maintained by increased subsidies to land managers through agri-environment schemes. Welsh culture becomes a feature of the tourist sector. Rural areas that are unable to adapt to tourism may decline; however, unemployment is generally low.

People relocate to the cities to fill the jobs created in the new light industries of biotechnology, opto-electronics and aerospace. Rapid advances in technology mean that the cities of the south are pleasant, environmentally-oriented places. Spatial planning in the cities is tightly controlled and the emphasis is on urban regeneration rather than urban sprawl into the countryside.

As agricultural land is abandoned, these areas are managed for nature conservation. Biofuels, windmills and renewable energy technologies increase and dependence on fossil fuels is reduced.

B2 – Fluffy lamb

In the increasingly regional and environmentally friendly world of Wales, the Welsh language and culture flourish, as do small industries and smallholdings. Organic farming increases and extensification of agriculture is supported by subsidies. Native deciduous woodland increases,

as do areas protected for nature conservation. GDP goes down but, as life is simpler, this does not necessarily reflect a drop in the standard of living.

The southern cities have well-maintained green areas and all new housing is energy-efficient, leading to decreased energy demands. Renewable energy is used as much as possible – wind-farms, hydro-electric, solar and biofuels all feature in this world.

Global travel decreases, but local recreation is still strong. However, this may mean that tourist revenue declines.

5 Identification of indicators for the different services

Suitable indicators for the different sectors were chosen and their sensitivity to the different drivers (socio-economic, climate and pollution) were classified as high (H), medium (M), low (L), or none (-) (Table 3). Some indicators are interdependent and these were identified and are shown in Fig. 4. For example, water quality is to some extent dependent on summer water quantity and on flood damage. Flooding leads to a decrease in water quality due to the inflow of polluted excess flood water from, for example, sewage treatment-plants. A low quantity in summer could possibly lead to higher concentrations of pollutants. In turn, polluted rivers and lakes and would make these waters less attractive to anglers and this would affect the number of fishing licences.

Table 3: The sensitivity of the indicators to the different drivers ranked as high (H), medium (M), low (L) or none (-).

INDICATORS	SECTORS	DRIVERS		
		socio-economic	climate	pollution
# livestock	Agriculture	H	L	L
pasture land (ha)	Agriculture	H	M	M
current timber increment (t ha^{-2} yr^{-1})	Forestry	-	H	M
total woodland area (ha)	Forestry	H	L	L
above-ground C stock (t ha^{-1})	Forestry	H	H	L
below-ground C stock (t ha^{-1})	Forestry	L	H	L
biodiversity index per SSSI	Nature Cons.	L	H	M
SSSI area (ha)	Nature Cons.	H	-	-
CIS Landscape diversity indices	Nature Cons.	H	-	-
# eisteddfods	Nature Cons.	H	-	-
% Welsh speakers	Nature Cons.	H	-	-
# national trust members	Nature Cons.	H	-	-
# hotel nights	Tourism	H	M	L
# fishing licences	Tourism	H	L	M
catch (t yr^{-2})	Marine	H	M	H
frequency of storm surges	Marine	-	H	-
water quality index	Water	M	L	H
summer water quantity (availability/demand)	Water	H	H	-
flood damage	Water	H	H	-
% renewable power	Industry/Energy	H	-	-

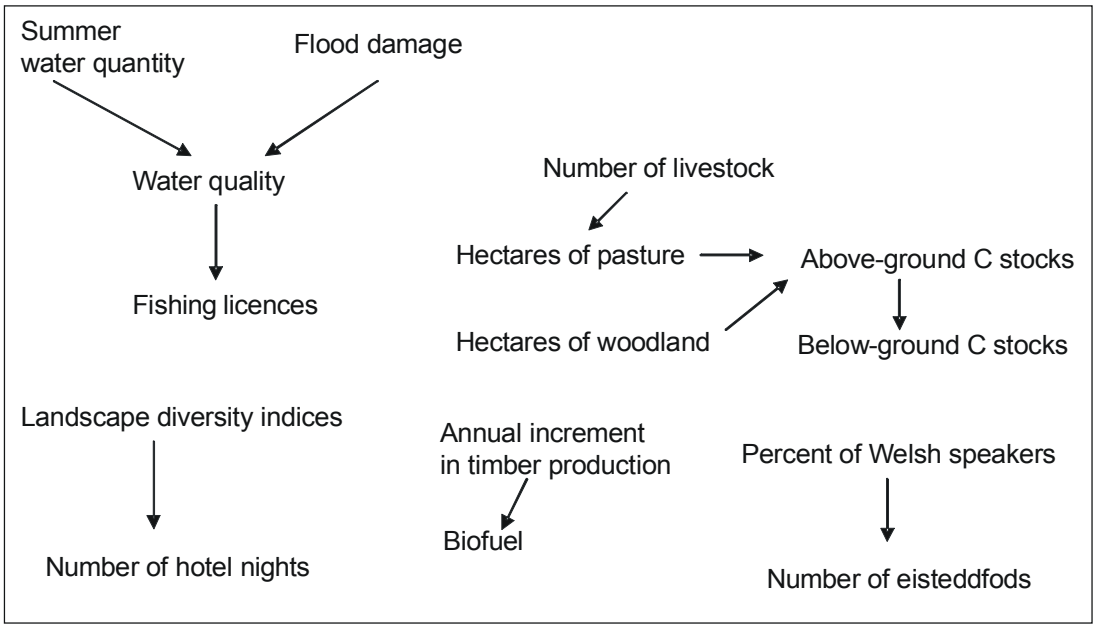

Figure 4: Web of interactions, showing the interdependence of the different indicators.

6 Assessment of the impact of different scenarios on the services

Based on the different scenarios and the sensitivity of the indicators, the impacts on the various sectors were assessed for the four regions under each of the scenarios (Table 4). A positive impact was classified as +, a negative impact as - and no change as 0.

Table 4: The total impact on the different sectors, for the different regions under each of the scenarios, labelled as positive (+), negative (-) or neutral (0).

upland	A1	A2	B1	B2
agriculture	-	-	-	-
forestry	+	+	+	+
Nature Conservation	-	-	+	+
water	0	0	+	+
tourism	-	-	+	-
industry / energy	0	0	+	+

lowland	A1	A2	B1	B2
agriculture	-	-	0	0
forestry	+	+	0	0
Nature Conservation	-	-	+	+
water	-	-	+	+
tourism	-	-	+	-
industry / energy	0	0	+	+

urban	A1	A2	B1	B2
Nature Conservation	-	-	+	+
water	-	-	+	+
marine	-	-	-	-
tourism	+	-	+	-
industry / energy	-	-	+	+

coast	A1	A2	B1	B2
Nature Conservation	-	-	+	+
water	-	0	+	+
marine	-	-	0	+
tourism	+	-	+	-
industry / energy	-	-	+	+

The current retreat of agriculture continues, particularly in the uplands, where conditions are more difficult. Under environment-oriented scenarios (B), this is partly compensated for by subsidies for maintaining traditional landscapes and a shift from intensive to extensive agriculture (focus on quality rather than quantity). Where agricultural land is abandoned, forests tend to expand, which has a positive impact on services such as carbon sequestration. Issues such as biodiversity are not considered important in economy-oriented scenarios (A); therefore, no resources are invested in nature conservation and its services.

In the B scenarios, freshwater quality improves, as well as protection against flooding through better management. In A scenarios these will deteriorate, particularly in heavily populated regions (lowland, urban). In the marine sector, frequencies of extreme events (floods, storms)

increase and fish populations decline. Better management of the coastal areas partly compensates for this in the B scenarios.

Tourism is expected to decline in the regionalised scenarios (type 2) as people travel less. In the A1 scenario, tourism concerns mainly cities and coastal resorts, while in B1 eco-tourism is also developed in rural areas. Since the decline of the mining industry Wales's main natural resources are wind and hydropower, which are more likely to develop under B scenarios.

7 Adaptive capacity

The vulnerability of any system to external stress (or collection of stresses) is a function of exposure, sensitivity and adaptive capacity. Human and natural systems tend to adapt autonomously to gradual change and to change in variability, but human systems can also plan and implement adaptation strategies in an effort to reduce potential vulnerability or exploit emerging opportunities even further (IPCC, 2001).
In the context of climate change, adaptive capacity is the potential or capability of a system to adjust, via changes in its characteristics or behaviour, in order to be better able to cope with existing climate variability or with changes in variability and mean climatic conditions. A system may be a country, region, community, household, economic sector, business, population group or other system, such as an agricultural system (Brooks and Adger, 2004). Although this relates to climate change, this definition of adaptive capacity can be applied to any change in the variability or mean of any variable that defines a system's environment.
Having adaptive capacity depends on the resources available for adaptation, the ability of those who need to adapt to deploy these resources effectively and their willingness to do so. The resources that contribute to a human system's adaptive capacity include natural resources, financial capital, human capital, knowledge of risk, appropriate social institutions for managing risks and appropriate technology (Brooks and Adger, 2004).
Judging adaptive capacity depends critically upon both defining a coping range (a range of circumstances within which, by virtue of the underlying resilience of the system, significant consequences are not observed) and understanding how the efficacy of any coping strategy might be expanded by adopting new or modified adaptations (Yohe and Tol, 2002).
It was beyond the scope of this report to assess the adaptive capacity of different sectors of the Welsh economy. However, it is possible to present the findings of the UKCIP Wales scoping study (Farrar in McKenzie Hedger *et al.*, 2000), which assessed the ability of different sectors of the economy to cope with climate change. Although these findings relate only to climate change and not to other exposures, they provide a helpful starting point for assessing Wales's adaptive capacity.

In general, Wales's ability to change is limited by the relatively low mean GDP and poorer skills base compared with other parts of the UK. The Welsh Assembly needs to develop economically viable strategies that recognise the interactions between climate change, agriculture, conservation and water resources. Table 5 summarises the potential of the different sectors for adaptive capacity.

Under different scenarios, Wales's adaptive capacity for the different drivers varies. The socio-economic drivers are both global and local. The adaptive capacity for the different sectors to the socio-economic drivers is dependent not only on the financial state of the region but also on the regional political agenda, i.e. which sectors are given greatest priority. It is therefore difficult to distinguish adaptive capacity from socio-economic drivers since these, at least at a regional level, are strongly connected to how well that sector is able to adapt. The adaptive capacity to the climate changes and pollution drivers also depends on regional politics and also on how well the ecosystems are able to adapt to the drivers. Table 5 shows examples of how these ecosystem services can adapt to the climate and pollution drivers.
The adaptive capacity of the different sectors under the different scenarios is shown in Table 6. This capacity is scenario-dependent for most of the sectors. However, the adaptive capacity

to changes in the marine ecosystem services is generally very low due to the fact that the changes in these occur as a result of changes at a global level, and there are few possibilities of adaptation at a regional level.

Table 5: Possible adaptive capacity strategies for the different sectors.

Sector	**Adaptive capacity**
Agriculture	The adaptive capacity of rural areas is relatively high. National Parks constitute a considerable percentage of land area and the parks typically think and plan across sectors on a long time scale. Furthermore, Wales has gained significant experience of planning and decision making across sectors from the agri-environment schemes Tir Cymen and Tir Gofa
Forestry	*See Agriculture*.
Nature conservation	*Biodiversity*: The range and frequency of some species (nightingale, kingfisher) may increase, while others (arctic alpine plants, dipper) may decrease. The design of Biodiversity Action Plans (BAPs) and the criteria for site designation of, for example, SSSIs and National Nature Reserves (NNRs) do not allow for climate change impacts. This is a serious problem as Wales has over 1,000 designated areas."
Water	*Flood protection:* According to the UKCIP Wales Scoping Study (Farrar, 2000) both coastal flooding (sea-level rise, storm surges and wave heights) and inland flooding are set to become significantly more frequent. Institutional changes are needed to improve adaptive capacity. *Water industry*: The water supply companies are acutely aware of climate change and its long-term implications. Water supply may be unable to meet summer demand over a significant proportion of Wales by 2025 due to the predicted changes in the seasonality of precipitation. The regulators of the water utilities set short-term, customer driven goals for their sectors and these goals are notable in lacking any long-term environmentally-based component.
Marine	*Flood protection:* According to the UKCIP Wales Scoping Study (Farrar, 2000) both coastal flooding (sea-level rise, storm surges and wave heights) and inland flooding are set to become significantly more frequent. Institutional changes are needed to improve adaptive capacity.
Tourism	*Tourism*: Since much tourism in Wales is outdoor and 61% of it coastal, this section will be significantly affected by climate change.
Industry and Energy	*Energy*: The energy supply companies are acutely aware of climate change and its long-term implications. Energy generation will be more affected by mitigation than by adaptation policies, although overhead lines will be subject to damage by severe weather. The regulators of the power utilities set short-term, customer driven goals for their sectors and these goals are notable in lacking any long-term environmentally-based component. *Insurance*: Aware of and geared to the consequences of climate change. *Other businesses*: Less well informed or concerned about the necessity to adapt to climate change.

Table 6: Indication of level of adaptive capacity per sector under the different scenarios.

	A1	A2	B1	B2
agriculture	L	L	H	M
forestry	L	L	M	M
nature cnservation	L	L	H	M
water	M	L	H	M
marine	L	L	L	L
tourism	L	L	H	L
industry/energy	H	L	M	L

8 Conclusions about the vulnerability of Wales to global change

The vulnerability tables per land class (Table 4) show that some trends occur independently of the scenario. For most sectors, however, there is a difference in the vulnerability between the scenarios. In general, the regionalised scenarios, where subsidies will be available to maintain the traditional countryside, are more favourable for Wales. General conclusions for the different land classes are as follows:

Uplands

In all scenarios the extensive agriculture of the uplands declines. Abandoned areas are available for forestry, which enjoys an increase in all scenarios. Under the globalised scenarios, rural communities decline, resulting in a decrease in the vulnerability of the water sector. The regional scenarios are most favourable for the uplands because subsidies are available to maintain the traditional landscape.

Lowlands

For the lowlands there is a large difference in vulnerability between the globalised and regionalised scenarios. In a globalised world agriculture will decline, whereas in a regionalised world subsidies allow a continuation of current land-use practices.

Coastal

Coastal regions are more exposed to flooding under all the scenarios; however, under the regionalised scenarios this does not lead to an increase in vulnerability due to a lower population density. For the other sectors, the coastal region is similar to the lowlands.

Urban

Under the globalised scenarios urban areas grow. This leads to higher pressures on ecosystem services, thus increasing vulnerability for most sectors, as opposed to the regionalised scenarios where vulnerability decreases. Flood risks are, however, a concern under all scenarios.

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