



ToPDAd

TOOL-SUPPORTED  
POLICY-DEVELOPMENT  
FOR REGIONAL ADAPTATION

# HOW WILL CLIMATE CHANGE AFFECT TOURISM FLOWS IN EUROPE?

Adaptation options  
for beach and ski tourists  
assessed by ToPDAd models

Results of the ToPDAd  
research project, 2012–2015

# Executive summary

## HOW WILL CLIMATE CHANGE AFFECT TOURISM FLOWS IN EUROPE?

Adaptation options  
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With climate change, mean temperatures and precipitation patterns will change in Europe. This will have consequences for the traditional tourism destinations. ToPDAd assessed how beach and ski tourists may react to changing weather patterns and how this will affect the competitiveness of various European tourism destinations. This can help decision makers and investors choosing the most cost-efficient strategies for adapting to climate change.

Many Europeans spend their summer holidays on the beach, with the Mediterranean beaches drawing most tourists. However, ToPDAd's modelling shows that Mediterranean beach destinations are likely to lose overnight stays during summer months due to climate change, to the benefit of beach destinations elsewhere in Europe. Beach

tourism on the aggregate will most likely gain from climate change, with beach season across Europe extending to autumn and spring. Adaptation measures such as promoting shoulder season tourism or alternative activities during summer may reduce the loss in overnight stays for Mediterranean beach destinations.

Skiing tourism will find it harder to adapt to climate change. Since the snow cover during winter is expected to deteriorate in most regions, it is highly likely that some tourists will drop skiing. ToPDAd's modelling shows that all skiing areas will lose overnight stays during the winter season, but there are regional variations. The loss might be limited by investing in all-year-round tourism, e.g. wellness stays. This will however not make up for the overall decrease in winter tourism.



# Key findings



## Changes in overnight stays for beach tourism

- Across Europe, conditions for beach tourism are expected to improve, as mean temperatures will rise. The beach season will be prolonged to spring and autumn.
- Competition between beach destinations in Europe will increase, as climate conditions at the Atlantic and northern European coasts improve. Yet, the Mediterranean region remains by far the most popular beach destination.
- At some Mediterranean beach destinations, temperatures during summer will be perceived as too hot by tourists, leading to a loss of overnight stays.
- Investments in buildings and technological solutions to reduce the perception of heat may reduce the loss of overnight stays during hot summer months in the Mediterranean. An increased use of air-conditioning and consequently the enhanced energy consumption, though, has implications on GHG emissions, unless the energy demand is covered by carbon-neutral sources.

## Changes in overnight stays for skiing tourism

- Due to climate change, snow conditions will worsen in most European ski resorts, and particularly in low-lying areas.
- Tourists could shift to comparatively snow-reliable areas. Overall, however, skiing areas will be confronted with a decrease in overnight stays as mean temperatures rise.
- Artificial snow-making, which currently is the most common supply-side adaptation strategy, will become more expensive. Enhanced use of snowmaking, however, exacerbates global warming due to an increase in energy consumption and additional strain on water resources.
- Investments in alternative activities during winter or all-year-round tourism can only partly compensate for the loss in overnight stays during winter.

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## Key facts about tourism in Europe

*The Mediterranean region is the world's most popular holiday destination. Each year it attracts about 120 million tourists from northern Europe, who jointly spend more than EUR 100 billion annually. International tourism contributes about 10% of GDP and employment in countries around the Mediterranean Sea. In some popular tourism destinations, the economic value of tourism is even bigger.*

*Also European winter sport areas attract millions of tourists every year, generating nearly EUR 50 billion in annual turnover. In the Alps, some municipalities almost entirely depend on revenues generated by skiing tourists.*

Source: Climate change, impacts and vulnerability in Europe 2012, EEA

# The ToPDAd toolset for tourism



Climate is an important resource for tourism. The ToPDAd toolset is designed to help decision makers at various levels – from local governments to private businesses in the tourism sector, to map future challenges related to climate change adaptation, as well as to evaluate which measures are best for their organisation.

ToPDAd has assessed the economic effects of climate change on beach tourism during the summer season (May–October), and alpine skiing during the winter season (November–April). The models map potential changes in overnight stays within seasons and changes in tourism flows, including shifts between regions as well as shifts in time and activity.

Other scientific studies have mapped the impact of climate change on touristic flows (see references at the end). ToPDAd complements the existing literature by analyzing beach and ski tourism at a refined spatial and temporal resolution. The toolset uses a new climate index, which puts more weight on precipitation so that climate change impacts in beach destinations can be forecast with more certainty. Moreover, ToPDAd couples sectoral and macro-economic models, which allows comparing regional and national adaptation priorities.

Thus, ToPDAd evaluates for the first time whether an increase in summer tourism in typical skiing areas across Europe could compensate for a loss in overnight stays during winter. In addition, we examine whether a potential growth of beach tourism during shoulder seasons could compensate for possible decreases during summer.

The modelling was done for three different climate change scenarios based on combinations of the greenhouse gas concentrations (so-called Representative Concentration Pathways-RCP) and socioeconomic scenarios (so-called Shared Socioeconomic Pathways-SSP). Under RCP 2.6 climate change remains limited and global warming would stop by mid-century thanks to timely and radical emission reductions. In RCP 4.5 global emission reduction efforts build up slower and less radical than in RC 2.6, resulting in more climate change while global temperature rise stops – almost – only by the end of the 21st century. In RCP 8.5 global emission reductions remain very modest, resulting in ongoing climate change and substantial global temperature rise by 2100.

# Assessing the effect of adaptation on overnight stays at beach destinations

The climate models used by ToPDAd, based on a geometric average of temperature, precipitation, and cloud cover index, indicate that conditions will become more favourable for beach tourism across Europe. The conditions in northern Spain and the southern Atlantic coast of France improve significantly and come close to the conditions of the Mediterranean. For northern Europe, small to significant improvements in the climatic conditions for beach holidays are expected, depending on the climate model considered.

Estimations say the optimal temperature for beach tourism is ca. 29 °C. (E.g. Ruty et al. 2010), while tourists also prefer dry and sunny weather. Under these assumptions, the Mediterranean area will remain Europe's most attractive areas for beach holidays. However, in some Mediterranean beach destinations, tourists may perceive the high temperatures during the summer months as uncomfortable.

Climatic conditions will also improve during the shoulder season (spring and autumn) across Europe, thus prolonging the beach season. This may allow Mediterranean resorts to compensate for a loss of tourists during summer. These will however have to compete with other regions in Europe, which also benefit from warmer conditions in the shoulder season. Consequently, Mediterranean resorts might not be able to compensate fully for a loss of overnight stays during summer.

Knowing how tourists will behave under a changed climate is crucial for future investments in touristic infrastructure. ToPDAd assessed several demand and supply side adaptation options and examined their effect on overnight stays at various beach destinations.

On the demand side, the following adaptation strategies are considered:

1. Tourists stick to the holiday type (beach tourism), but change time and/or destination, e.g. postpone their beach holidays to the shoulder season or change to regions with a better climate;
2. Tourists change the holiday type, e.g. drop beach holidays

Our modelling shows that the first adaptation option is likely. Most tourists at Europe's beaches come from northern Europe. As temperatures are expected to increase across Europe, northern European tourists might prefer staying close to home instead of travelling south. Some might also perceive the summer months in some Mediterranean resorts as too hot, and thus travel elsewhere or change their traveling date.

It is rather unlikely however, that tourist will replace their beach holidays by another holiday type, since conditions for beach holidays will improve in several European regions, combined with an extended beach season.

The adaptation capacity of the suppliers (touristic areas, hotels, etc.) is limited compared to the options tourists have to adapt to climate change. Whereas tourists typically make short-term decisions and are not bound to a certain location (with the exception of the owners of holiday homes), suppliers are often tied to particular destinations because they have made long-term investments.

Tourists' and suppliers' adaptation strategies are interdependent. For instance, an adaptation strategy of suppliers might be to influence tourists' choices, e.g. by investing in marketing, or offering in-door activities during

hot days. When assessing the effect of adaptation strategies for a particular region, it is also important to consider how competing destinations adapt. If the majority of regions invest in adaptation, regions that do not or cannot increase their resilience will face a comparative disadvantage. This could exacerbate the loss already caused by climate change.

On the supply side, this study assesses the following two adaptation strategies:

- Promoting a shift of touristic demand from the main season to the shoulder season
- Measures that reduce the perception of heat (e.g. constructional measures, shading, air conditioning etc.). In this case, temperatures above the optimal temperature for beach tourism do not negatively impact beach tourism demand.

The modeling, as shown in Figures 1.1 and 1.2, demonstrates that supply-side adaptation can significantly reduce losses of regions with too hot summer temperatures but cannot compensate for losses because of increased competition. Overall, climate change will lead to a shift in time of beach holidays. Warmer regions will see a shift to shoulder seasons, while cooler regions will shift towards the peak season.

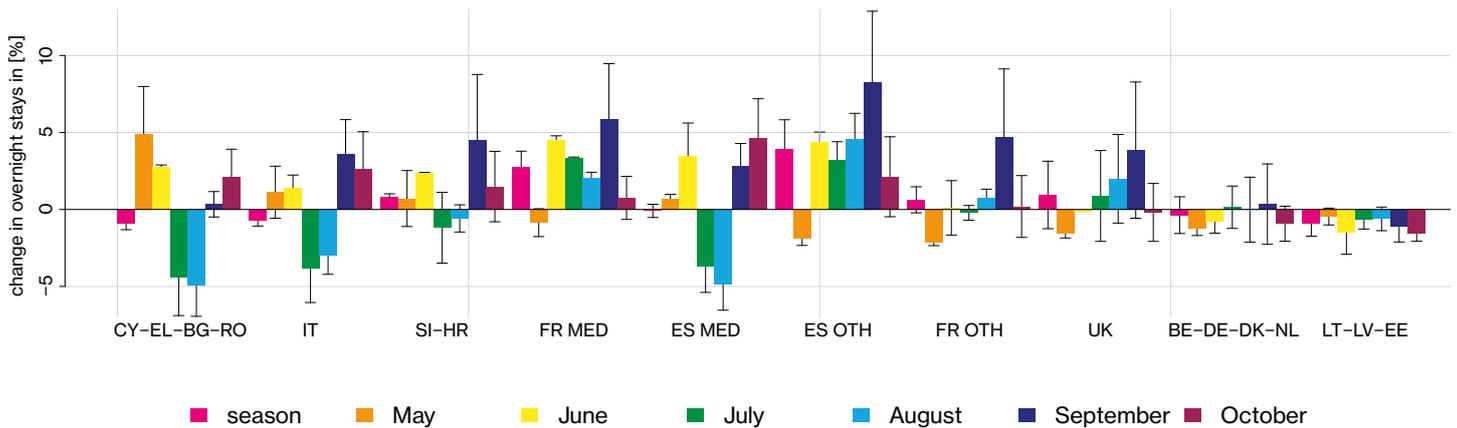


Figure 1.2: Summer beach tourism – average monthly change in overnight stays [%] (2035–2065 vs. baseline) for different regions with supply-side adaptation, based on SSP4 and RCP 4.5 (multi climate model mean; error bars indicate climate model uncertainty)

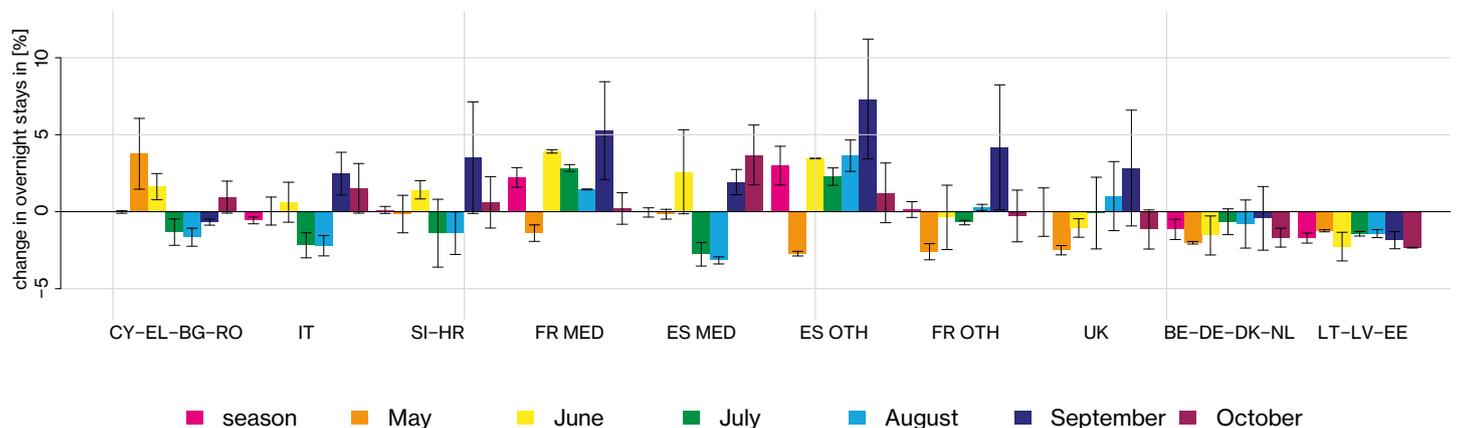


Figure 1.2: Summer beach tourism – average monthly change in overnight stays [%] (2035–2065 vs. baseline) for different regions with supply-side adaptation, based on SSP4 and RCP 4.5 (multi climate model mean; error bars indicate climate model uncertainty)

# Assessing the effect of adaptation on overnight stays at skiing resorts

Climate models predict that climate change will lead to a decrease in snow cover in Europe. Alpine skiing conditions during winter are expected to deteriorate in most regions, especially in low-lying ski areas. Increasing temperatures will also raise the cost for artificial snowmaking.

Whereas for beach tourism climate conditions will most likely improve in most regions and months compared to current conditions, for alpine skiing tourism conditions will worsen in all regions and months.

This study assessed several demand and supply side adaptation options and in particular, their effect on overnight stays at skiing stations across Europe. Starting with the demand side, winter tourists have similar adaptation options as beach tourists:

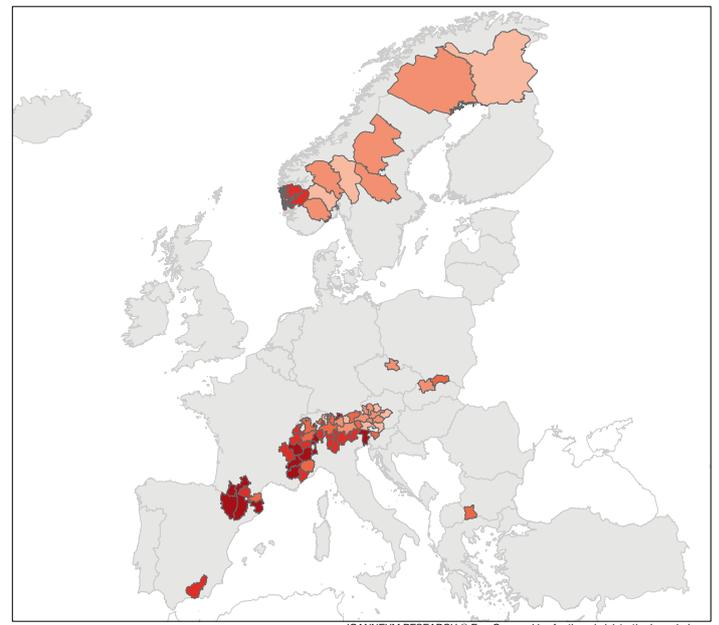


Figure 21 Change in winter overnight stays [%] (2035–2065 vs. baseline) based on SSP4 and RCP 4.5 (multi climate model mean): tourists adapt by changing holiday type.

1. Tourists stick to the holiday type but change time and/or destination, e.g. change to more snow-reliable ski areas;
2. Tourists change the holiday type, i.e. they stop skiing, but stick to the winter season.



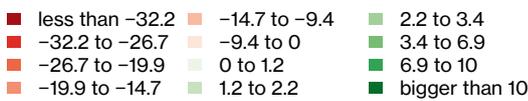
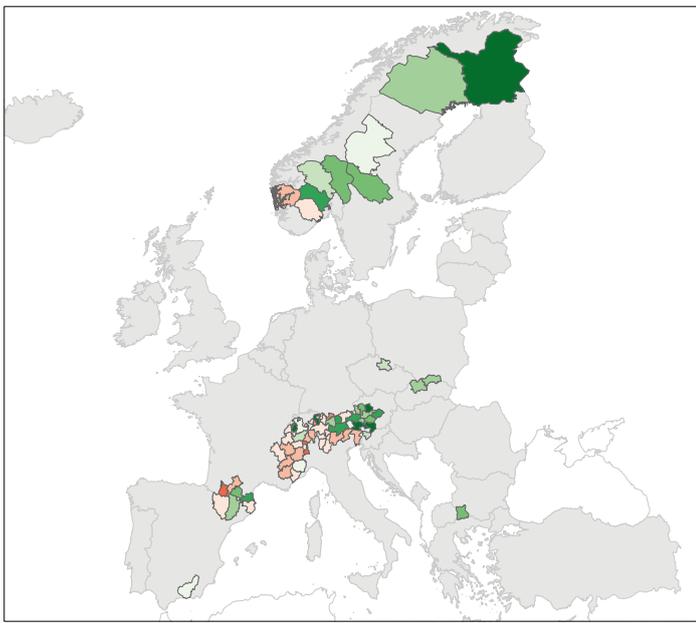


Figure 2.2 Change in winter overnight stays [%] (2035–2065 vs. baseline) based on SSP4 and RCP 4.5 (multi climate model mean): tourists adapt by changing destination and/or time of stay.

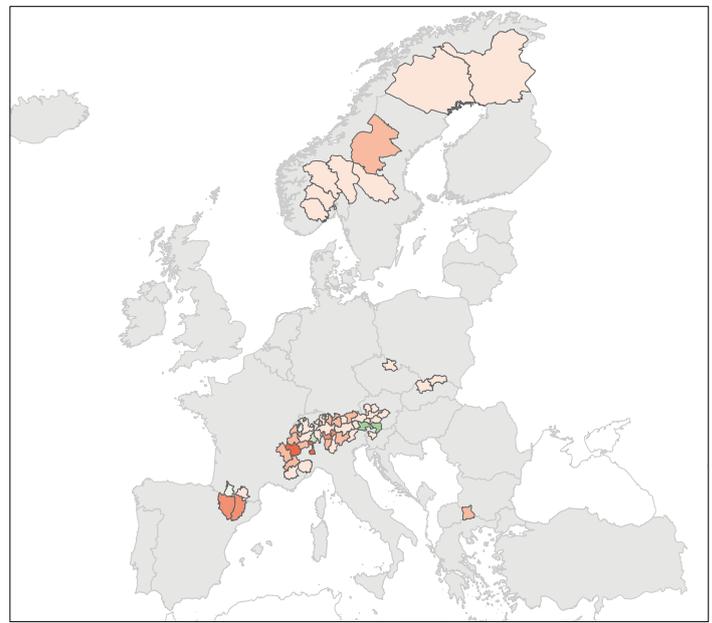


Figure 3: Change in overnight stays [%] (2035–2065 vs. baseline) for winter and summer season using SSP4 and RCP 4.5 (multi climate model mean).

Contrary to beach tourism, the risk for a drop in skiing tourism in Europe is real. Under the second, most drastic scenario (see Figure 2.1), all skiing areas face a reduction in overnight stays.

Under the more restrictive first scenario (see Figure 2.2), tourists change month (within the winter season) and/or destination, but continue skiing. This will affect the relative competitiveness of various ski areas in Europe. Ski areas in the southern part of the Alps (e.g. in France and Italy) will lose overnight stays whereas those in the northern parts of the Alps and Scandinavia can benefit from climate change.

As regards supply side adaptation, the skiing business has limited options to react to changes in climate and tourists' behavior.

Currently, artificial snowmaking is the most common strategy to adapt to variations in snow conditions. It covers 38% of the total skiing area in the European Alps and has increased by 48% since 2004 (EEA, Climate change, impacts and

vulnerability in Europe 2012). Yet in this model the impacts of artificial snow-making on tourism demand, energy and water consumption were not included; we only assessed natural snow data. We refer to other studies (Damm et al. 2014) for a case study on artificial snowmaking.

As an alternative adaptation strategy, the suppliers could try to influence the demand by increasing investments in marketing or increasing the offering of alternative activities both in snow-scarce winters and in summer. The latter could be increasingly relevant as climate models forecast better summer conditions for mountain regions. Aggregate winter and summer season effects (see Figure 3) show that skiing areas will see a rise in overnight stays due to climate change during summer. However, the increase in summer tourism cannot compensate for the losses during winter.

## References

Amelung, B. and Moreno A. (2012), "Costing the impact of climate change on tourism in Europe: results of the PESETA project". *Climate Change* 12(1), 83-100.

Barrios S. and Rivas, J.N.I. (2013), "Tourism demand, climatic conditions and transport costs: An integrated analysis for EU regions". Report for the PESETA II study on the impact of climate change in Europe (Report EUR 25937 EN).

Damm, A.; Köberl, J. and Pretenthaler, F. (2014), "Does artificial snow production pay under future climate conditions? – A case study for a vulnerable ski area in Austria". *Tourism Management*, 43, 8–21.

Hamilton, J.M. and Tol, R.S.J. (2007), "The impact of climate change on tourism in Germany, the UK and Ireland: a simulation study". *Regional Environmental Change* 7, 161-172.

Hamilton, J.M.; Maddison D.J. and Tol, R.S.J. (2005), "Climate change and international tourism: A simulation study". *Global Environmental Change* 15(3), 253–266.

Hein, H.; Metzger, M.J. and Moreno, A. (2009), "Potential impacts of climate change on tourism; a case study for Spain". *Current Opinion in Environmental Sustainability* 2009, 1(2) 170–178.

Köberl, J.; Pretenthaler, F., and Bird, D.N. (2015), "Modelling Climate Change Impacts on Tourism Demand: A Comparative Study from Sardinia (Italy) and Cap Bon (Tunisia)". *Science of the Total Environment*. <http://doi.org/10.1016/j.scitotenv.2015.03.099>

Lise, W. and Tol, R.S.J (2002), "Impact of climate on tourist demand". *Climatic Change* 55, 429–449.

Maddison D. (2001), "In search for warmer climates? The impact of climate change on flows of British tourists". *Climatic Change* 49(1–2), 193–208.

# About the ToPDAd toolset and project



ToPDAd stands for “tool-supported policy development for regional adaptation” to climate change. This EU-funded research project developed a toolset to help decision makers at various levels – from individuals and private businesses to national and European policy makers, mapping future challenges related to climate change adaptation and making a cost-benefit analysis of different adaptation strategies.

The ToPDAd toolset integrates climate scenarios and socio-economic data from 15 existing models, allowing for an integral assessment of adaptation strategies. It builds on a broad range of data – from the impacts on choices of transport routes and tourist destinations to impacts on macroeconomic indicators, such as GDP, sector composites, market prices and greenhouse gas emissions.

The toolset was applied on seven case studies from three economic sectors – energy, tourism and transport. While starting from local events and situations, the results of these studies are also relevant for and applicable in wider regions in Europe. The cases look forward to 2050 and some to 2100, while applying different climate scenarios, based on combinations of the greenhouse gas concentrations (so-called Representative Concentration Pathways-RCP) and socioeconomic scenarios (so-called Shared Socioeconomic Pathways-SSP).

The case studies cover the following themes: (1) summer beach tourism; (2) winter skiing tourism; (3) the effects of extreme events on traffic in cities; (4) new potential arising for shipping as a result of Arctic ice melting; (5 & 6) effects of climate change on energy production (renewable energy and nuclear energy); (7) the macro-economic impact of extreme rainfall in cities.

Decision makers at local level or SMEs often sit on different information than national decision makers or multinational companies. For example, the environmental impacts of artificial snowmaking might seem minor to the local community whereas from a national perspective, evaluations of the environmental concerns depend on how serious the impacts on tourism are to the nation. By integrating the results of the case studies in the macroeconomic model, we learn, firstly, that impacts on tourism in general may be limited because tourist activities

that are not climate sensitive will most likely expand. Secondly, since most regions will attract less foreign than domestic tourists, local impacts will depend on the composite of foreign and domestic visitors. Thus, by bringing together information from different sectors and disciplines and combining the output from both micro- and macro-models, ToPDAd is among the first to show strong interdependencies between various sectors and decision levels.

In addition, ToPDAd studied the potential consequences of climate change on public health and assessed adaptation strategies from a macro-economic perspective. Available studies on the impacts of climate change on public health focus primarily on mortality under heat waves. Adaptation strategies therefore focus mainly on monitoring vulnerable people during heat waves and enhancing services to tackle heat stress. This is for example relevant for beach tourism, which is one of the case studies of ToPDAd. Integrating the available knowledge on health impacts in a macroeconomic model however reveals some broader consequences of climate change on public health. While some affected people might need surgery, others will need to rest more and become less productive. This may also affect labour productivity. In other words, adaptation strategies need to go beyond monitoring vulnerable people, but also need to take into account the labour market. Again, these results show the importance of an integral cost-benefit assessment of adaptation strategies, as is done with the ToPDAd toolset.

*For more information on the research project and its outputs, visit [www.topdad.eu](http://www.topdad.eu) or explore how results may be relevant for your sector or region with the interactive tool at <http://topdad.services.geodesk.nl/>.*

The research project ran from October 2012 to September 2015 and received EUR 4 556 233 in funding by the European Union's research programme FP7 under agreement number 308620. It involved ten research institutes from nine European countries, coordinated by VTT Technical Research Centre of Finland Ltd.

