Water for life and livelihoods

River Basin Management Plan
Severn River Basin District

Annex G: Pressures and risks

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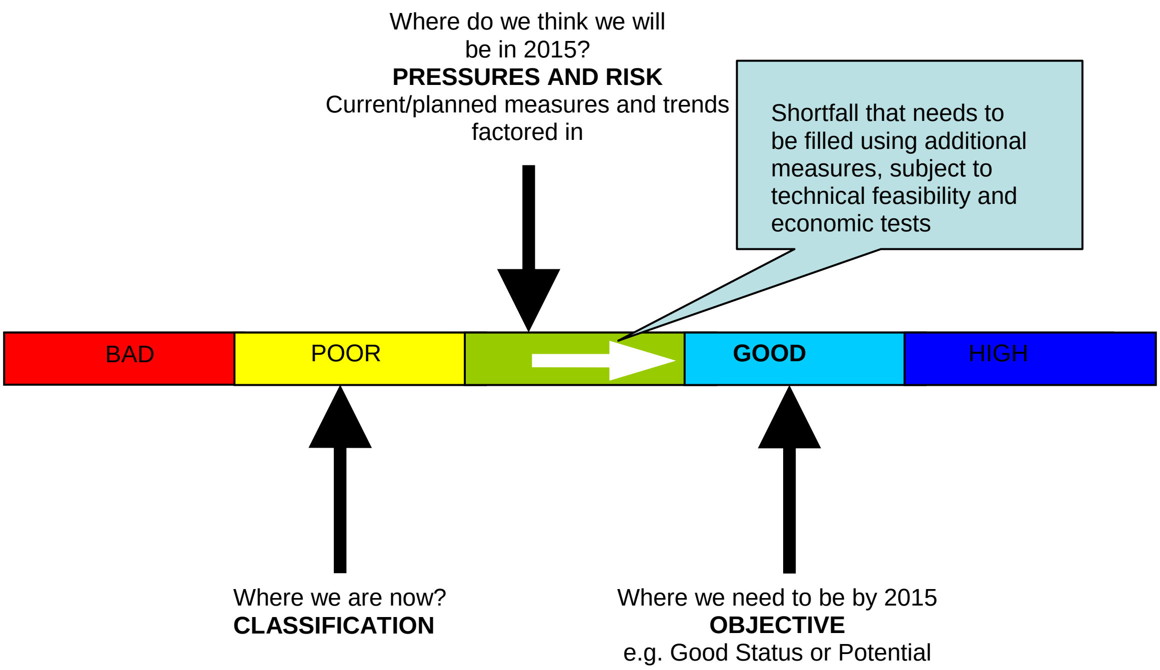
G.1 Introduction

This annex provides a summary of the significant pressures and the risks resulting from humans' activities on the status of surface water and groundwater. The Water Framework Directive requires the management of risk to the environment caused by anthropogenic pressures, not just their impacts. There is a fundamental difference in terms of the management approach required to meet these needs. Managing impact is 'reactive', whereas managing risk is 'proactive', requiring the ability to identify where an impact might occur (or is occurring) and prevent it from happening in the future. For example, we issue consents to discharge effluent to water or licences to abstract water that minimises the impact before it happens and is based on the risk to the water from the activity and the sensitivity of the water.

We need to assess the risks posed to the environment, in terms of failing to achieve the objectives of the Water Framework Directive (e.g. Good Status or Potential) either now or in 2015. Information on trends enables action to be taken to prevent water bodies being impacted in the future. This is critical given the timescales imposed by the Directive for achieving Good Status (see Figure G.1).

The measures in Annex C will aim to **further reduce the current impact** of pressures, ensure **no deterioration** and **reduce the risks** posed to the environment so future impacts are less likely.

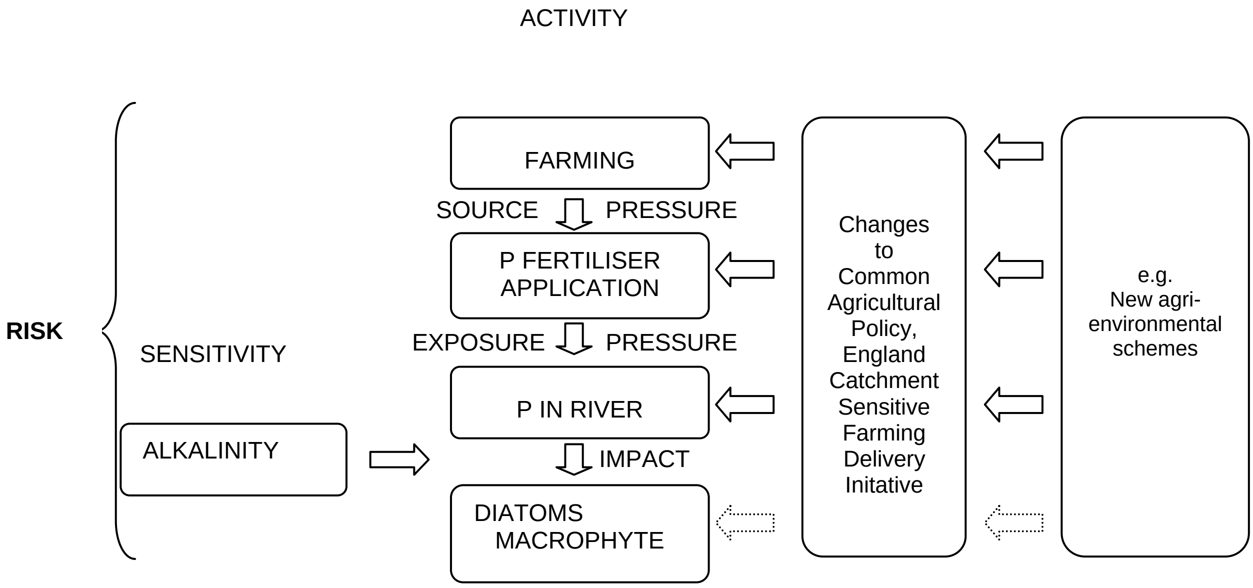
Figure G.1: **Simple overview of how classification and risk are used to define objectives and measures**



The consideration of pressures and risks (potential impacts) help build up an evidence base that can justify the objectives and the actions to deliver them (see Annex C - Programmes of Measures). Figure G.2 shows an example of the risk model used.

Further information on how the Environment Agency produced the risk assessments and the methods used can be found at http://www.environment-agency.gov.uk/research/planning/33238.aspx

Figure G.2: **Example of conceptual risk model using example of the pressure from phosphate (P) fertilisers**



G.2 Information on significant pressures

Previously we have looked at pressures in the context of:

- Estimating point source pollution.
- Estimating diffuse source pollution, including land use.
- Estimating pressures on the quantitative status of water including abstractions.
- Analysis of other impacts of human activity on the status of water.

Risk assessments to assess the risk of not achieving the default objectives of the Water Framework Directive have been produced for different sources of pressures under these headings and can be found at http://www.environment-agency.gov.uk/research/planning/33268.aspx.

For protected areas, assessments of compliance are presented separately in Annex D.

In the River Basin Planning : Summary of Significant Water Management Issues report for the Severn River Basin District, a series of environmental pressures were considered; these are listed in Figure G.3.

Figure G.3: **Pressures affecting the water environment**

WFD PRESSURES	Specific pressures considered
Point source pollution	• Organic pollution - including ammonia and biochemical oxygen demand • Chemicals - including priority hazardous substances, priority substances, specific pollutants • Other Pollutants - faecal indicator organisms • Acidification • Nutrients - nitrate, phosphorus • Mines and minewaters
Diffuse source pollution	• Chemicals - including priority hazardous substances, priority substances, specific pollutants (including pesticides) • Oil and hydrocarbons • Sediments
	• Organic pollution - including ammonia and biochemical oxygen demand • Other Pollutants - faecal indicator organisms • Acidification • Nutrients - nitrate, phosphorus • Mines and minewaters
Pressures on the quantitative status of water	• Abstraction and other artificial flow pressures • Physical modification - morphology
Other impacts on the status of water	• Physical modification - morphology • Invasive non-native species • Biological pressures - including fish stocking, biota removal • Sediments • “Emerging” substances such as endocrine disrupters • Urban and transport pressures • Recreation (e.g. boating, fishing) • Saline intrusion into groundwater bodies (resulting from abstraction pressures)

These are generalised categories and it is recognised that some pressures, such as ammonia, may be included in more than one category. It is also acknowledged that diffuse source pollution may also include unspecified point sources dispersed over a wide area.

The effects of climate change on the environment are another pressure that should be considered when understanding how to protect or improve the status of water bodies. Temperature changes in the environment may be linked to changes in species, habitat and water quantity and availability, for example. The source of local temperature changes may be traced to specific activities such as cooling water from power stations, as the by-product of power generation. We are still learning how we can monitor and predict the effects of temperature changes for the future. Annex H discusses the effects and impacts of climate change on the river basin scale in more detail.

For the Severn River Basin District, a number of specific pressures were identified as significant water management issues:

- abstraction and other artificial flow pressures
- invasive non-native species
- nitrate
- pesticides
- phosphorus
- physical modification (estuaries and coasts)
- physical modification (rivers and lakes)
- sediment (rivers and lakes)
- urban and transport pollution.

Pressures that were found **not to** represent significant water management issues at a district level in this river basin district, but may still have a significant effect at local level are listed as follows and described further in Section G.3:

- acidification
- commercial fisheries
- faecal indicator organisms
- mines and minewaters
- organic pollution
- metals
- priority hazardous substances and chlorinated solvents
- recreation

The next sections describe the significance and extent of the specific pressures which have been identified as significant water management issues in the Severn River Basin District.

Note that the statistics for river water bodies include rivers, surface water transfers and canals. Lake water body statistics include lakes and Site of Special Scientific Interest (SSSI) ditches.

i) Abstraction and other artificial flow pressures

Periods of naturally low flows are caused by extended periods of low rainfall (e.g. during droughts) and are part of the mechanism that supports bio-diversity. Low flows can be prolonged or made worse by unsustainable levels of abstraction for public water supply, industry, agriculture or domestic use. Unsustainable abstraction from groundwater can lower groundwater levels and affect dependent river flows or wetlands, or can induce the intrusion of poorer quality water from the sea or from deeper aquifers.

Other artificial influences on flow include the discharge of treated sewage, transfer of water between catchments and the storage and release of water from reservoirs. These influences may offset some of the impacts of abstraction, or result in flows being significantly higher or lower than they would naturally be.

Flow in surface water bodies is a supporting element to biological classification for all classes other than High status, for which it is an obligatory consideration. Outflow from groundwater bodies contributes to the surface water flows required to support the biological classification.

Unsustainable rates of abstraction reduce surface water flows and may result in lower flow velocities, reduced depths and reduced flow continuity that may limit ecological status. In addition, groundwater pumping may locally reduce spring flows and water levels important to retaining the ecological diversity and resilience of groundwater fed wetlands. Such impacts can be magnified in periods of reduced rainfall common in eastern England.

Ecological impacts can also arise from water being diverted for other uses. For example, fish farms can take a substantial amount of water out of rivers and return it further downstream. The ecology in the ‘deprived reach’ between the inlet and outlet can be significantly affected. Flow impacts can also arise from river channels being over widened or poorly managed.

Assessments indicate that most of the Severn River Basin District has no water available for further abstraction licensing at low flows. Some river catchments and groundwater aquifers are over-licensed or unsustainably abstracted at low flows e.g. parts of the district around the Upper Avon (Warwickshire), middle Severn and parts of South Wales are over-licensed or unsustainably abstracted at low flows.

The largest use of water is for public water supply coming from surface water reservoirs, rivers and from groundwater. Much of the water for public water supply and industry is treated and returned to the freshwater environment and is therefore available for re-abstraction. However, the treated water is often returned some way from where it was originally abstracted. There are also major transfer schemes which import and export water into and out of catchments within the river basin district and also out of the district altogether. For example, there is a gravity fed import of water along the Elan Valley aqueduct from the Elan Valley Reservoir in Wales to Birmingham. There is also a canal transfer from the River Severn to the Gloucester Sharpness canal for export to Bristol.

Water is also used for a wide range of other activities including industry, agriculture, power generation, navigation and angling, recreation and amenity.

Groundwater is an important resource for direct abstraction for public water supply, farming and industry. In some areas groundwater levels have fallen to an unsustainable level which has put the environment at risk. The restoring sustainable abstraction programme is investigating and addressing those abstractions thought to be adversely affecting the environment.

Restricted or low flows can lead to higher residence time along some river stretches. These, combined with higher concentrations of nutrients such as phosphate and nitrate, may lead to algal blooms. More frequent periods of low summer rainfall are expected under current climate change scenarios, which may increase the environmental impact of flow problems.

There are 3,197 abstraction licences within the Severn River Basin District authorising abstraction of 2,701,864 million litres of water a year. These abstractions cover water taken from rivers or the ground, both from freshwater and tidal reaches.

Figure G.4: **Summary of abstractions in the Severn River Basin District**

Sector	Licensed volume (Ml/ year)	Number of Licences
Water Supply	1,347,299	405
Agriculture	53,931	2,182
Fish and Aquaculture	58,861	68
Electricity Production	1,016,847	14
Industry	210,091	510
Other	14,835	18

Our latest assessments of the pressure show that:

- 918 km (11%) of river length is at risk or probably at risk from abstraction and flow regulation (see Figure G.4.1)
- Three (4%) of lakes are at risk or probably at risk from abstraction and flow regulation (see Figure G.4.2)
- 8179 square kilometres (40%) of groundwater are at risk or probably at risk from abstraction and flow regulation (see Figure G.4.3, G.4.4, G.4.5 and G.4.6).

ii) Invasive non-native species

Invasive non-native species are plants and animals that have deliberately or accidentally been introduced outside their natural range, and by spreading quickly threaten native wildlife and can cause economic damage. Some species pose serious threats to our natural biodiversity and have economic impacts for example, for flood risk management, water transfer schemes, disposal of soil as waste and fisheries management. Their presence and unabated spread can represent an important pressure on the ecological status of many water bodies. Once established they are difficult or impossible to control. Examples include the plant Japanese knotweed, the mammal American mink, the fish topmouth gudgeon and the crustacean American signal crayfish.

A number of species introduced to the UK continue to cause local and regional problems. Within the Severn River Basin District species of particular note include the widespread invasive plants Japanese knotweed, Himalayan balsam and giant hogweed. Floating pennywort is currently confined to the Gwent Levels and Gloucestershire and concern over its impacts has led to a collaborative control project in the former. Common cordgrass is present in the Severn Estuary, having been introduced historically as a coastal defence measure. Amongst invasive animal species, American mink, zander and American signal crayfish are widespread, whilst the zebra mussel is a particular concern in Cardiff Bay.

Water bodies that have a significant presence of invasive non-native species will not meet 'high ecological status' under the Water Framework Directive. Their presence, however, will not always prevent achievement of good ecological status.

Our risk assessments show that of 791 river water bodies in the Severn River Basin District, 138 (17%) are probably at risk of failing WFD objectives in 2015 due to direct effects of invasive non-native species on the achievement of good ecological status. Out of 75 lake water bodies one (1%) is probably at risk, and no estuarine waters (0%) are at risk. See Figures G.4.7, G.4.8 and G.4.9.

Additional evidence

The National Strategic Assessment flagged invasive non-native species as being a potentially significant issue requiring further research and more investigation. A robust evidence base could then be developed to support the assessment of objective impacts or targeting further measures at specific sectors. A risk-based approach is being adopted for the control of invasive non-native species. The Environment Agency is an active partner in the "Invasive non-native species framework strategy for Great Britain" (2008) which takes a risk-based approach to make the best use of available resources. The delivery of this strategy will rely on the work of local partnerships.

iii) Nitrate in surface water and groundwater

Nitrate pollution can impact on both surface water and groundwater and comes principally from agriculture (61%) and sewage treatment works discharges (32%) (figures for England and Wales, Defra 2004). In urban areas the main inputs are from contaminated land, leaking sewers and water mains. The magnitude and balance of diffuse and point sources vary across river basin districts, as will the extent of inputs to surface and groundwater.

High nitrate concentrations are thought to be the main cause of eutrophication in estuarine and coastal waters and may also contribute to eutrophication in certain types of freshwaters. Eutrophication is described as the enrichment of waters by nutrients, causing excess plant and algal growth and leading to undesirable effects on the ecology, quality and/or uses of the water. High nitrate concentrations can impact on terrestrial ecosystems, such as wetlands, for example, through excessive nettle growth. High nitrate concentrations in drinking water are a threat to human health and are controlled by meeting the standards of the Drinking Water Directive (50mg/l nitrate for water and at the point of supply).

Defra and Welsh Assembly Government have identified nitrate standards to support Good Ecological Status in saline waters. They will be applied such that targeted measures will be taken where eutrophication is occurring. There are no equivalent ecological standards for nitrate in relation to the ecological status of surface freshwaters - the 50 mg/l drinking water standard continues to drive action.

The Environment Agency's risk assessments for the Water Framework Directive indicate that 1995 km (24%) of total river length or 21% of the total number of river water bodies are at risk or probably at risk of failing the 50mg/l threshold for nitrate in the Severn River Basin District (see Figure G.4.10).

Nitrate levels in groundwater are of particular significance as around 20 per cent of the drinking water within the river basin district comes from this source[1], and there are controls on the amount of nitrate that is acceptable in drinking water. All groundwater bodies have been designated as Drinking Water Protected Areas.

Few groundwater sources for public supply received more than simple purification treatment 30 years ago. Rising nitrates in drinking water taken from groundwater have previously been dealt with by blending water from different sources to achieve the drinking water standard. With the widespread rise in nitrate concentrations, low nitrate waters for blending are becoming very limited and water supply companies are now installing treatment plants. If the current trend in increasing treatment continues, then 83% of sources in England and Wales will need treatment for nitrates by 2029.

The latest assessment shows that ten (25%) groundwater bodies within Severn River Basin District are at risk of failing their environmental objectives as a result of nitrate (see Figure G.4.11). Two of the five tests used to assess groundwater chemical status directly consider nitrate impact – the General Chemical Test and the Drinking Water Protected Area test.

[1] Environment Agency 2007, River Basin Planning, Summary of Significant Water Management Issues, Severn River Basin District, Consultation Document 2007.

Nitrate impact is also considered when carrying out the Groundwater Dependent Terrestrial Ecosystem test (wetlands). The current results of these tests are listed below:

Figure G.5: **Groundwater tests**

Test	Number (and percentage) of groundwater bodies failing the test for nitrate in the Severn River Basin District
Drinking Water Protected Area test	8 (20%)
General Chemical test	4 (10%)
Groundwater Dependent Terrestrial Ecosystem test	0 (0%)

In addition, nine groundwater bodies in the Severn River Basin District (22.5%) had a significant and sustained increase in nitrate concentration in groundwater (see Figure G.4.12). This test is not part of status. There is a specific and separate objective to reverse environmentally significant upward trends in groundwater.

iv) Pesticides

'Pesticide' is a general term that includes all chemical and biological products used to kill or control pests. Pests are living organisms such as rodents, insects, fungi and plants that harm our food, our health or our environment. Pesticides are used in domestic, amenity, forestry, horticultural and agricultural scenarios. Because of their toxic nature they can cause harm to 'non-target' organisms and if they are not stored, used and disposed of properly they pose a risk to terrestrial and aquatic wildlife. As well as ecological impacts, pesticides can also contaminate surface water and groundwater bodies used as drinking water sources, thus increasing the need for treatment.

Sheep dip is a veterinary medicine used to treat parasites on sheep (e.g. scab, blowfly, ticks and lice). The two active ingredients used in sheep dip products are diazinon and cypermethrin (although the use of products containing cypermethrin is currently suspended). Both these substances are highly toxic to invertebrates and very small levels in rivers can cause severe ecological damage. Studies have shown that they can interfere with salmon reproduction by disrupting the ability of the male fish to respond to female hormones.[2,3]

Tributyltin is a biocide. European regulatory controls now prevent its use in products for the EU market. Historically its main use was to prevent fouling on shipping; however it was also used in wood preservation, paper and pulp and textiles. Whilst its use has now been restricted it is highly persistent in the environment. It is also known to be a contaminant in PVC.

[2] Moore, A. & Waring, C.P., 1995. Sub-lethal effects of the pesticide Diazinon on olfactory function in mature male Atlantic salmon (*Salmo salar* L.) parr. *Journal of Fish Bio*logy **48,** 758-775.

[3] Moore, A. & Waring, C.P., 2001, The effects of a synthetic pyrethroid pesticide on some aspects of reproduction in Atlantic salmon. *Aquatic Toxicology* **52**, -12.

Figure G.6: **Significant issues groups that include pesticides**

Significant Issue Group	Principle source of pesticides
Diffuse pollution from rural areas	Sheep dip application, application of pesticides to crops.
Diffuse pollution from urban areas and transport	Anti-foulants on boats, application of pesticides to hard surfaces for weed control.
Point source pollution	Discharges of treated effluents from pesticide manufacturing plants (via STWs), spillage incidents.

The latest assessments for pesticides for the Severn River Basin District show that:

- 2940 km of rivers are at risk or probably at risk from diffuse agricultural pesticides (see Figure G.4.14).
- 1888 km of river is at risk or probably at risk from sheep dip (see Figure G.4.15).

We have estimated that less than one per cent of the total length of rivers in the Severn River Basin District are at risk from point sources of pesticides (see Figure G.4.16). We have estimated that 18 groundwater bodies in the Severn River Basin District are probably at risk from pesticides (see Figure G.4.17).

There are a number of other lines of evidence of indirect impacts, these include:

The Environment Agency report 'The Unseen Threat to Water Quality'[4] reports the widespread failure of the EQS for tributyl tin and its effects on dog whelk populations. The report also states that pesticides were detected in nearly one-fifth of groundwater monitored. It reported that in certain areas these concentrations were declining.

v) Phosphorus in rivers and standing waters

High phosphorus concentrations are the main cause of eutrophication in fresh waters (see Figure G.4.19). Eutrophication is the enrichment of waters by nutrients causing excess plant/algal growth and leading to undesirable effects on the ecology, quality and uses of the water. Activities that can be affected include water abstraction, water sports, angling, wildlife conservation and livestock watering. In standing fresh waters, blue-green algal blooms can occur; many such blooms are toxic and pose a hazard to humans involved in water sports and to animals that drink the water.

Defra and Welsh Assembly Government have identified phosphate standards to support Good Ecological Status in fresh waters. They will be applied such that measures will be targeted to water bodies where there is evidence that nutrient levels are causing undesirable ecological impacts. Benefits should be seen from the planned introduction of phosphate reduction at sewage treatment works discharging to waters identified as Sensitive Areas under the Urban Waste Water Treatment Directive.

There are predicted reductions in livestock by 2015 with a general move from farming in the uplands to the lowland areas of England, which is expected to reduce the amount of phosphate entering waters. Other changes in agriculture predicted in the Business as Usual Projections of Agricultural Outputs[5] work will need to be reassessed in the light of unexpectedly large changes in commodity prices, which together with reductions in set aside, are likely to increase intensity of arable production. Reducing phosphorus pollution is one of

[4] Environment Agency 2007, The Unseen threat to water quality, Diffuse Pollution in England and Wales, May 2007.

[5] Environment Agency: *Business as Usual Projections of Agricultural Outputs*
Centre for Rural Economics Research, University of Cambridge, Environment Agency, July 2004.
http://www.environment-agency.gov.uk/economics

the aims of the England Catchment Sensitive Farming Delivery Initiative, particularly where related to designated sites such as SAC and SSSI rivers, and also one of the aims of the Environment Agency Wales Catchment Initiative. It is also included in the new Welsh Land Management Scheme (Glastir) which will commence in 2012.

Phosphorus has been considered to be of far less significance to groundwater (see Figure 4.18). Research is currently being carried out on the impact of phosphorus on surface waters and habitats that are sensitive to groundwater seepage and spring flows.

Measures to limit nitrogen loss in Nitrate Vulnerable Zones also reduce P losses. If NVZ designations are introduced or extended in the Severn this would also help reduce the phosphorus loading in some of our surface waters.

The control measures within Nitrate Vulnerable Zones under the Nitrate Directive, although primarily designed to reduce nitrate pollution, are likely to bring indirect benefits, through improved nutrient management, in terms of reduced agricultural phosphorus pollution.

The SIMCAT models used for the latest combined phosphorus assessment estimate that 53% of the rivers in the Severn are at risk from phosphorus enrichment. It also tells us that 75% of the phosphorus load is derived from point sources and 25% is derived from diffuse sources.

It is estimated that over 56% of the total length of river water bodies are at risk or probably at risk from diffuse phosphorus from agricultural pollution (see Figure G.4.20).

A range of tools have been used to assess the risk to rivers from phosphorus to provide a broad a picture as possible of the sources and impact of the pressure. However, in order to capture the broad range of potential sources the methodologies employed to develop the two risk assessments differ. As a result the outputs for Diffuse phosphorus from agriculture risk assessment and the Combined Phosphorus risk assessments aren't directly comparable, but when considered separately the individual assessments highlight the likely relative risk from each pressure. Please refer to the method statements for each assessment for further details.

vi) Physical modification (morphology)

The ecology of estuarine and coastal waters in the river basin district can be affected by a number of physical habitat pressures. These include land claim, shoreline reinforcement and dredging activities. The existence of weirs or tidal sluices can limit the migration of fish such as salmon, restrict sediment movement, promote siltation, and prevent natural mixing between fresh and saline waters with consequent impacts on estuarine ecological communities. Coastal defences may inhibit the inland migration and maintenance of inter-tidal habitats squeezed by sea level rise as a result of climate change.

Many lowland rivers in England and Wales have also been subject to physical alteration[6]. These modifications include channel straightening, bunding, bank re-profiling and dredging for flood prevention, drainage or navigation purposes, as well as the creation of new channels for mill leats or irrigation. Weirs, sluices and other impoundment in the river network may restrict the migration of migratory and freshwater fish such as eels, salmon and lamprey, impede sediment movement, promote siltation, and disrupt the interconnections between accessible habitat, particularly during periods of low flow. Such pressures may result in ecological habitat damage or loss.

Many lakes and reservoirs have been subject to significant physical alteration, and the artificial manipulation of water storage and levels behind them. Some are wholly artificial, being constructed in a site where no water body existed before.

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[6] Environment Agency 2007, River Basin Planning, Summary of Significant Water Management Issues, Supporting document, Severn River Basin District, Consultation Document 2007.

Further evidence is needed on how hydromorphological pressures influence ecology. There is extensive research being undertaken to look at this issue and also how different mitigation measures can improve the ecology of physical modifications[7].

Figure G.7: **Activities that include physical modifications to estuaries and coasts and rivers and lakes**

Significant Issue	Physical modification issues
Physical modifications	• Control structures • Dredging • Land claim • Aggregate extraction • Flood risk management • Impoundments

Our latest tests showed that for morphological pressure:

- Six (100%) of all estuarine water bodies in the Severn River Basin District are at risk or are probably at risk of failing Water Framework Directive objectives in 2015. Specific pressures include land reclamation, shoreline reinforcement, dredging and aggregate extraction; (see Figure G.4.21)
- 3226 km (39% of total length) of rivers are at risk or probably at risk of failing Water Framework Directive objectives in 2015 due to morphological pressure; (see Figure G.4.22)
- 63 (84%) of lake water bodies are probably at risk from morphological pressures (see Figure G.4.23)

vii) Sediment (rivers and lakes)

The term 'sediment' refers to anything that is not dissolved or in solution and which filtration or settlement can remove. The term includes solids that are floating on top of, or suspended within, the water.

Much of the sediment we are concerned with is caused by the erosion of soil. Whilst there is a natural level of erosion, it is the increased rates of erosion – caused by land based activities such as forestry, construction and, particularly, agricultural cultivation and grazing practices - that need to be addressed. It is worth noting that phosphorus is often associated with sediment as it is bound to soil (unlike nitrates, which are more soluble). Metals and many toxic organic compounds can accumulate in sediments. However, in some cases (for example, estuaries) sediment is an essential component of the ecosystem to maintain mudflats and salt marsh habitats.

High concentrations of suspended solids can:

- Bury fish eggs in the stream bed or coat their surface if they are on vegetation, causing suffocation.
- Cause physical damage to fish gills which can result in death, a reduction in growth or cause a reduction in resistance to disease.
- Reduce the populations of river bed animals which are the food of fish.
- Suppress photosynthesis due to a reduction in light penetration and by coating.

[7] Environment Agency 2007, Management strategies and mitigation of measures for Heavily Modified Water Bodies & Artificial Water Bodies in relation to ecological potential , Summary of Projects: March 2007, Internal document.

Demonstrating evidence of ecological impact as a result of human influenced sediment load is, however, difficult.

The direct effects of sediment include: impairment of spawning gravels for fish; siltation of reservoirs and navigable waterways; obstruction of drains and river channels; and increasing flood risk. Sediment also increases turbidity, which reduces light penetration and oxygenation of water. This results in reduced productivity, direct damage to fish gills from suspended sediment and reduced organism survival, especially for fish.

Conversely insufficient sediment in rivers, estuaries, and coastal waters causes erosion of important or protected habitats such as wetlands, mudflats, salt marshes, and beaches. Erosion of riverbanks can occur, along with bank collapse and river profile degradation. There may be downstream erosion of the river bed, damaging infrastructure and resulting in morphological changes which can alter the ecology.

The indirect effects of sediment include those resulting from current and historic point and diffuse sources of pollution. Many pollutants (metals, nutrients and organic compounds such as polyaromatic hydrocarbons) can be held on and released from sediments. This can result in reduced growth and breeding success of the river bed animals (such as invertebrates) which form the basis of the aquatic food chain.

Indirect effects may be temporary in nature as contaminated sediments (for example, those contaminated with metals, nutrients, and organic compounds such as polycyclic aromatic hydrocarbons, polychlorinated biphenyl, and persistent organic pollutants such as pesticides) are re-suspended at times of high flows. This may happen more often in a changing climate. This can impact on the wider environment, for example when contaminated sediment settles on floodplains following flooding.

The latest characterisation maps show that 3231 km of river water bodies (39% of total length) are at risk or probably at risk from the direct effects of sediment (see Figure G.4.24). In addition, trout spawning beds in 57% of reaches surveyed across England have levels of fine sediment at which half the eggs and larvae would be expected to die. More than 40% of freshwater wetland Sites of Special Scientific Interest (SSSI) in England are in unfavourable condition, with sediment a contributory factor in most cases. The Salmon Stock Conservation Review (2004) identified sedimentation as the first, or equal first, factor identified as cause of failure in 12 of the 22 Welsh Salmon Action Plan (SAP) rivers.

Note that the large water bodies that were split into smaller bodies at the end of 2008 have not yet had a new sediment risk assessment, and so have been reported as Not Assessed. However, the assessment made on the original smaller water body has been taken into account as part of a wider weight of evidence to appraise and determine appropriate measures. See Annex E for further information on the measures appraisal undertaken to manage sediment pressures.

viii) Urban and Transport Pressures

Various pollution issues relate to the urban environment and transport networks. These include:

- Urban drainage containing a variety of pollutants, such as:
    - phosphorus from misconnections (e.g. washing machines incorrectly plumbed into the surface water sewer instead of the foul)
    - organic waste (dog fouling) from parks and pavements
    - fertilisers used in gardens
    - sediment from construction sites
    - a range of pollutants which are present in run-off from roads including contaminated sediment, metals, organic substances

- Air emissions from vehicles which are then deposited to water or land (and in some cases can cause acidification).
- Pesticides used to control weeds on roads, pavements, railway tracks and other amenity areas such as parks and playing fields.
- Run-off from air strips that may contain de-icers and pesticides to control weeds.
- Dredging and maintenance of navigable waterways that can result in water quality issues from suspended solids and leaching of contaminants from the sediment.
- Leaching of pollutants from contaminated land.

Our latest information shows that 107 river water bodies are at risk or probably at risk for urban diffuse pollution. See also the section on phosphorus (G.2), sediment (G.2), and organic pollution (Section G.3) for the latest detailed information.

G.3 Other water management issues

Other water management issues were identified as affecting the water environment at a local level in the River Basin Planning : Summary of Significant Water Management Issues report for the Severn River Basin District. These are described below.

ix) Acidification

Acidification is the process whereby nitrogen oxides, sulphur dioxide and ammonia released into the atmosphere are converted into acidic substances. Acidification can cause toxic metals to leach out of soils and enter surface or groundwater. Various land-use practices such as farming and forestry can lead to acidification of watercourses, causing loss of sensitive plants and animals. At present, there is no evidence of impact from acidification on the district's water bodies. Our latest view of river basin characterisation showed that of 791 river water bodies in the Severn River Basin District, 44 (5.6%) are at risk or probably at risk of failing Water Framework Directive objectives in 2015 due to acidification (see Figure G.4.25).

x) Commercial fisheries (estuaries and coastal waters)

Commercial fishing or shell-fishing can represent an important pressure on the ecological status of estuarine or coastal water bodies, including the condition of EC designated Shellfish Waters (Protected Areas incorporated within the Water Framework Directive). This may involve the direct capture and removal of fish or shellfish, or the wider habitat damage that can result from some types of fishing which drag the seabed or estuary substrate. Initial characterisation (risk assessment under Article 5 of the Water Framework Directive) focused on the potential for physical habitat damage associated with fishing activities but also noted the need for a more holistic consideration of the direct impacts of fish or shellfish removal. Commercial fishing or fish farming may also have a detrimental ecological impact in fresh waters - either through the large scale netting of migratory fish such as eels or salmon, or through the influence of fish stocking or farming on natural populations. Fish farming may also have associated abstraction or pollution pressures.

xi) Faecal indicator organisms

Micro-organisms occur in vast numbers in the natural aquatic environment. The greatest waterborne risk of infection to humans is through drinking water or shellfish contaminated by pathogenic (that is, infection causing) organisms, such as bacteria or viruses, from sewage or animal excrement. However, infection (such as gastroenteritis – inflammation of stomach and gut) can also occur through ingesting contaminated seawater or freshwater during bathing.

It is impractical to test water for every known pathogen in every sample, and it has therefore become standard practice to test water for 'faecal indicator organisms'. Whilst generally harmless in themselves, their presence in water are an indicator of sewage or animal contamination and the potential for pathogenic organisms to be present.

The European Bathing Waters Directive (1976) includes faecal indicator organisms such as faecal coliforms, total coliforms and faecal streptococci. The recently revised Bathing Waters Directive (2006), with objectives set in line with the Water Framework Directive for 2015, takes account of more recent public health research and uses the faecal coliform *Esherichia coli* and the faecal streptococci intestinal enterococci as its faecal indicator organisms.

The Environment Agency monitors faecal indicator organisms in those waters identified under the EU Bathing Waters and Shellfish Waters Directives and the Government uses the results to report the level of compliance with the Directives' faecal indicator organism standards each year. See Annex D for details of the relevant Protected Areas (areas designated as recreational waters and areas designated for the protection of economically significant aquatic species) and their compliance.

xii) Mines and minewaters

Minewaters are usually acidic (low pH) and the main contaminants are metals, for example copper, iron, manganese and zinc. Minewater may also contain priority substances such as cadmium and lead. These contaminants are released when oxygen in the air or water reacts with minerals in the rock found near coal seams and mineral veins. The metals are then dissolved in the groundwater which discharges back into surface water bodies, or by rain in the case of spoil heaps. Such minewater related pollution may have significant ecological impacts.

For example, 47 river water bodies are at risk, or probably at risk from mines and minewaters (see Figure G.4.26) and five groundwater bodies are at risk, or probably at risk, from mines and minewaters (see Figure G.4.27).

Please note that there is some overlap between the pressure category "Mines and minewaters" and some metals that are covered in section G.3. Also note that metals in minewater discharges have been designated as priority substances, priority hazardous substances and specific pollutants. The objectives for these types are described in Annex E.

xiii) Organic pollution (ammonia and biochemical oxygen demand)

For the purposes of our assessments, organic pollution is comprised of ammonia and biochemical oxygen demand. The toxicity of ammonia to fish and other aquatic life is dependent on the pH and temperature of the water. Increasing pH increases the proportion of toxic 'free' ammonia. Biochemical oxygen demand is not an individual pollutant, but a measure of the amount of biodegradable organic matter present. A high concentration of biochemical oxygen demand exerts a high oxygen demand on water, leading to oxygen depletion with potentially severe impacts on the whole ecosystem.

Much of the pressure from organic pollution is the result of discharges of treated sewage effluent. Tightening of discharge standards and cessation of discharges of raw sewage to coastal waters over the past 15 years has resulted in marked improvements in water quality. National classification schemes based on organic pollutants have reflected this as shown in figures for General Quality Assessment compliance from 1990 to 2007.

Our latest risk assessments show that:

- 809 km (10% of total length) of river water bodies within the Severn River Basin District are at risk or probably at risk of failing the ammonia standards (see Figure G.4.28);

- 735 km (9%of total length) of river water bodies within the Severn River Basin District are at risk of failing the biochemical oxygen demand (BOD) standards[8] (see Figure G.4.29).

xiv) Other Pollutants

Metals

Metals are naturally occurring in the environment and many are needed in small amounts by organisms to function properly. However, they can be toxic to aquatic organisms such as freshwater fish, invertebrates and marine organisms in larger quantities. Metal pollutants are covered under a number of other pressure categories including urban and transport (section G.2), mines and minewaters (section G.3) and chemicals, including priority hazardous, priority and specific polluting substances (section G.3 and Figure G.4.30).

Chemicals including priority hazardous substances, priority substances & specific pollutants (excluding pesticides)

The Environmental Quality Standards Directive designates the most polluting substances as priority substances and priority hazardous substances. The list includes pesticides (see also section G.2) and other synthetic organic chemicals including chlorinated hydrocarbons, but also some naturally occurring substances such as metals. The severity of their effects depends on the availability to organisms, the nature of the particular substance and the susceptibility of the biological receptor.

Severe contamination can result in lethal effects to the extent that the habitat becomes characterised by tolerant or opportunistic species. In less severe circumstances, sub-lethal impacts may affect the physiology, growth and development and reproduction of organisms in the water column and sediment. Furthermore, a number of these substances bio-accumulate and many persist in sediments. The most polluting have been termed priority hazardous substances and the aim is to eliminate discharges of these substances to the aquatic environment wherever possible.

Information gathered to monitor environmental quality and compliance with other Directives shows that chemicals cause problems for the water environment in the Severn River Basin District. The pressure from tributyltin is a concern at specific sites and is covered in discussions in relation to pesticides in section G.2.

Our initial view of risk assessments reported that 32 out of 791 river water bodies were either at risk or probably at risk of failing Water Framework Directive objectives based on an assessment against Dangerous Substances Directive compliance. Note that the standards in the Dangerous Substances Directive will be replaced by the Environmental Quality Standards Directive (2008/105/EC). (See Figure G.4.31).

There are no groundwater bodies at risk from hazardous substances (not including pesticides) and there are three groundwater bodies probably at risk from chlorinated solvents (see Figures G.4.32 and G.4.33).

Endocrine Disrupters

Hormones control essential processes in animals and plants, such as growth, metabolism, reproduction and the functioning of various organs. Some chemicals can disrupt the normal working of the hormonal system(or endocrine system), and these are referred to as 'endocrine disrupting substances'. These substances may mimic the action of natural hormones, block their action, interfere in feedback mechanisms or have other effects.

There is considerable evidence of impacts on fish development, growth and reproduction, demonstrated particularly where male fish have become feminised. The Defra EDCAT project is currently investigating effects on fish populations and this will be completed in 2010. The severity of the effects of endocrine disrupting substances depends on a range of

[8] BOD is not used for classification

variables which are not yet fully understood, but include exposure to these substances (possibly at particular stages in the life cycle and the duration of that exposure), the nature of the particular substance and the susceptibility of the biological receptor.

Recreation (e.g. boating and fishing)

Recreational activities on or associated with water may have a direct impact on its quality or on the ecological assemblages within it. Boating activity, if intensive in shallow river or lake waters, may be associated with raised levels of suspended solids, bank erosion and fuel related pollution. Recreational angling may also lead to impacts on fish communities unless sensitively and sustainably managed.

G.4 Mapped outputs - the current view of pressure risks

The following pages include mapped outputs for the current view of risk for the pressures described in this annex.

Understanding the maps

The results of our risk assessments are displayed through maps showing which water bodies are at risk of failing the Water Framework Directive objectives in 2015. These assessments do not reflect the current quality or status of a water body, rather the risk that they may fail objectives as a result of pressures acting on them.

The maps show the risk of failing Water Framework Directive objectives with the following colour key:

- Water body at significant risk of failing objectives - dark purple
- Water body probably at significant risk of failing objectives - light purple
- Water body probably not at risk of failing objectives - pink
- Water body not at risk of failing objectives - pale pink
- Water body not assessed – white

A water body may be "not assessed" if the risk assessment has not been applied to it. For example, where large water bodies have been split into smaller water bodies late in the river basin planning process, the risk assessment may not have been subsequently applied to the smaller water bodies. These risk assessments will be updated during the first cycle of river basin management planning.

Figure G.4.1: **Abstraction and other artificial flow pressures (rivers)**

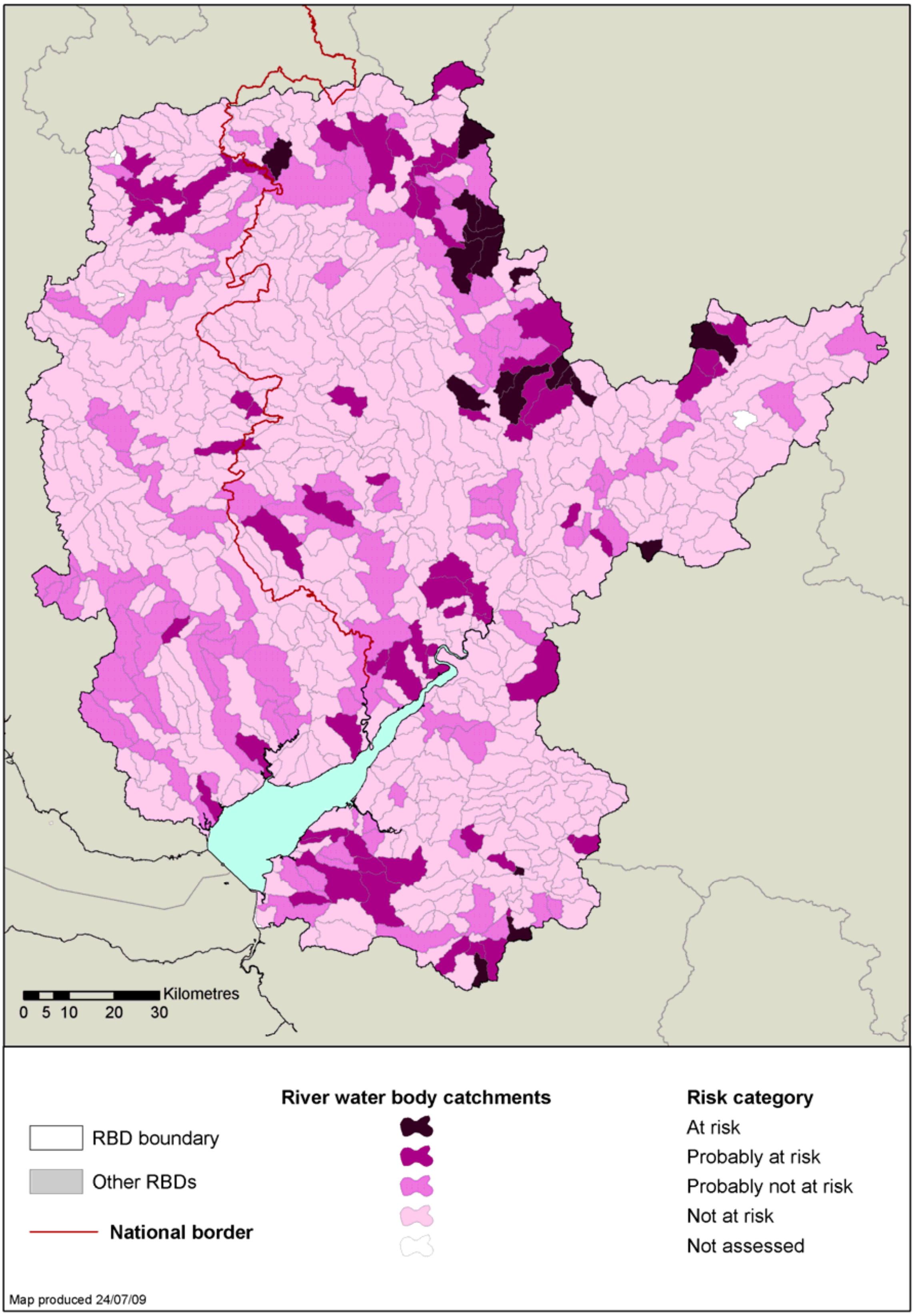


Figure G.4.2: **Abstraction and other artificial flow pressures (lakes)**

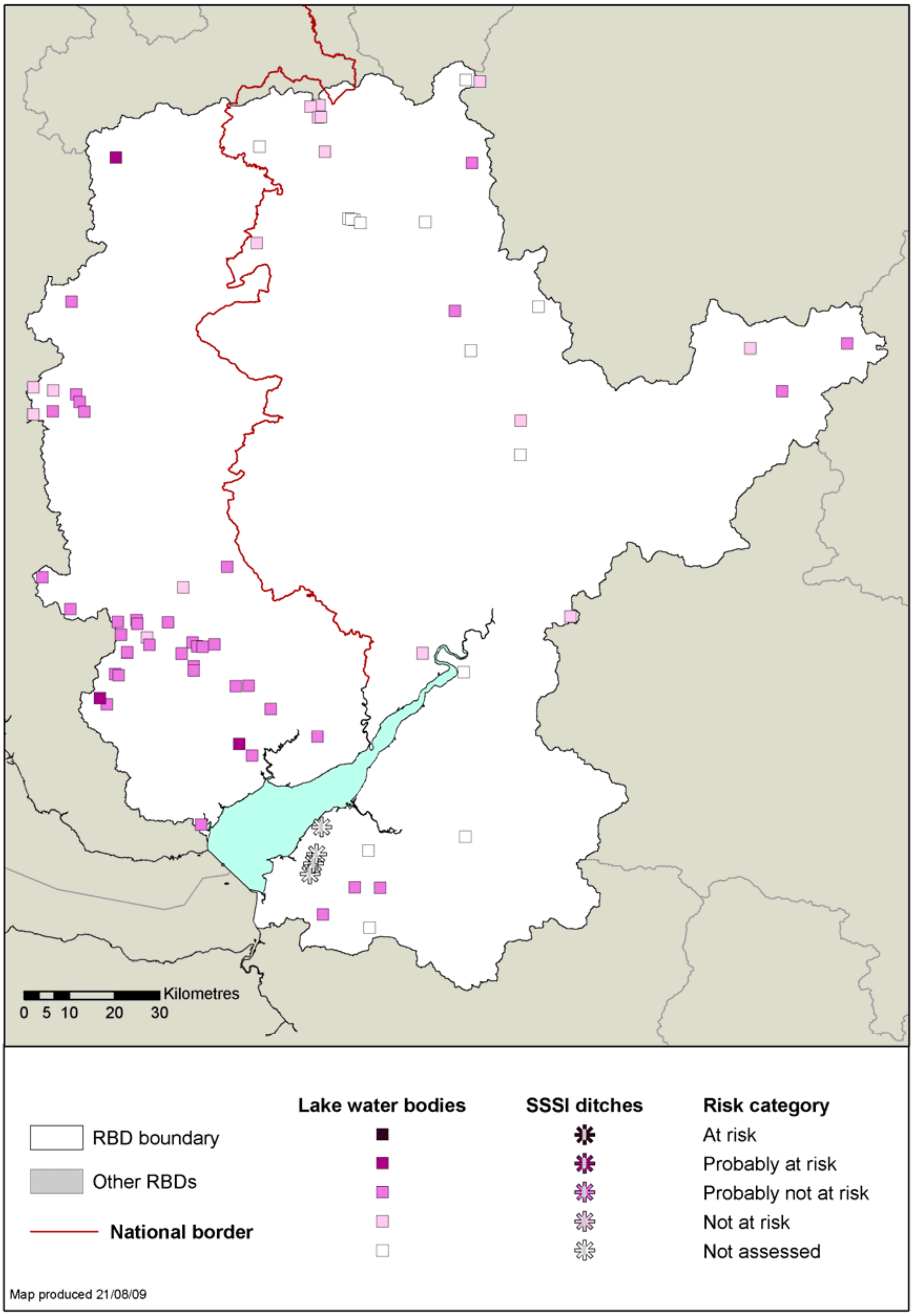


Figure G.4.3: **Abstraction and Flow Regulation - Impact on surface water (groundwater)**

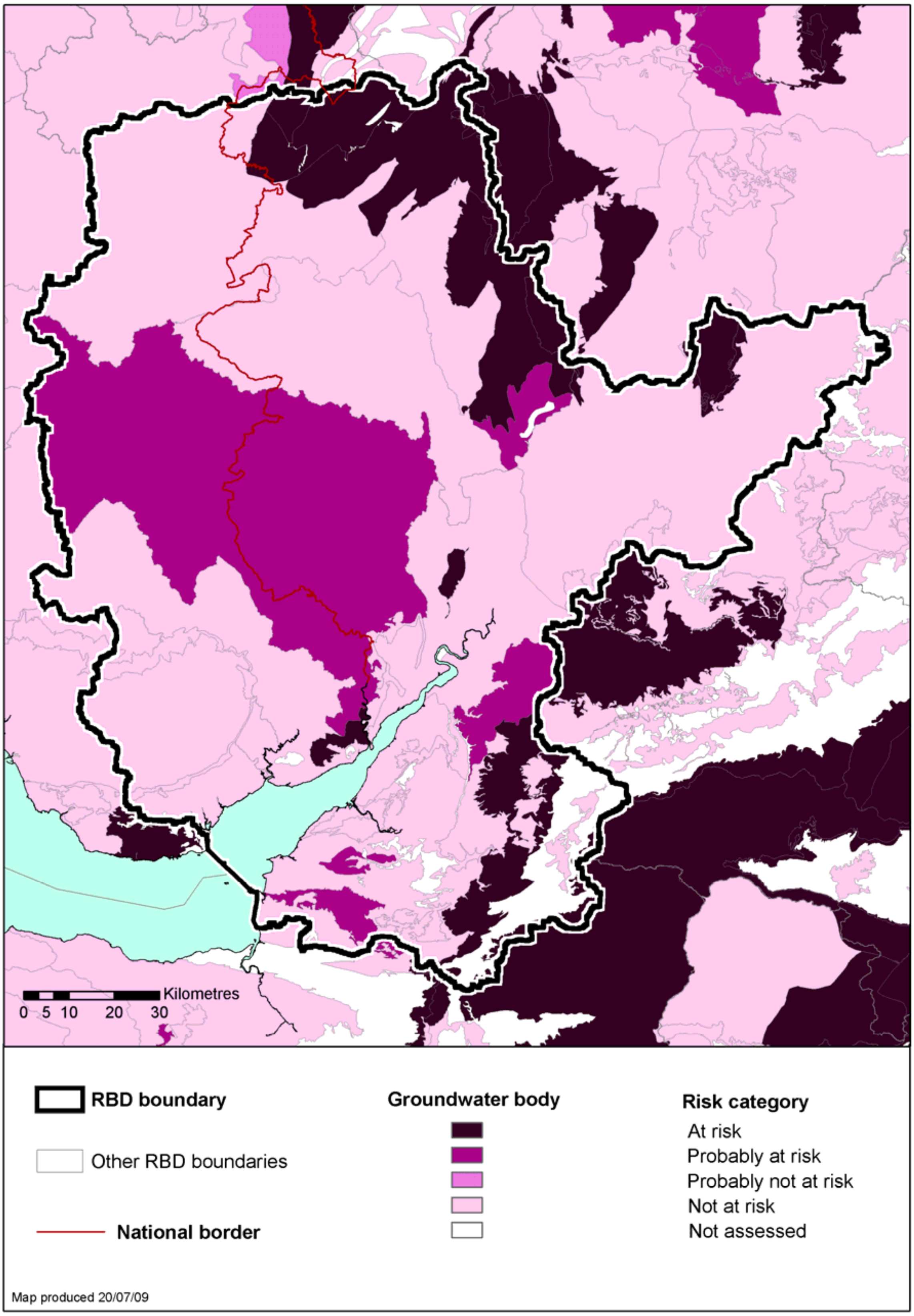


Figure G.4.4: **Abstraction and Flow Regulation - Saline intrusion (groundwater)**

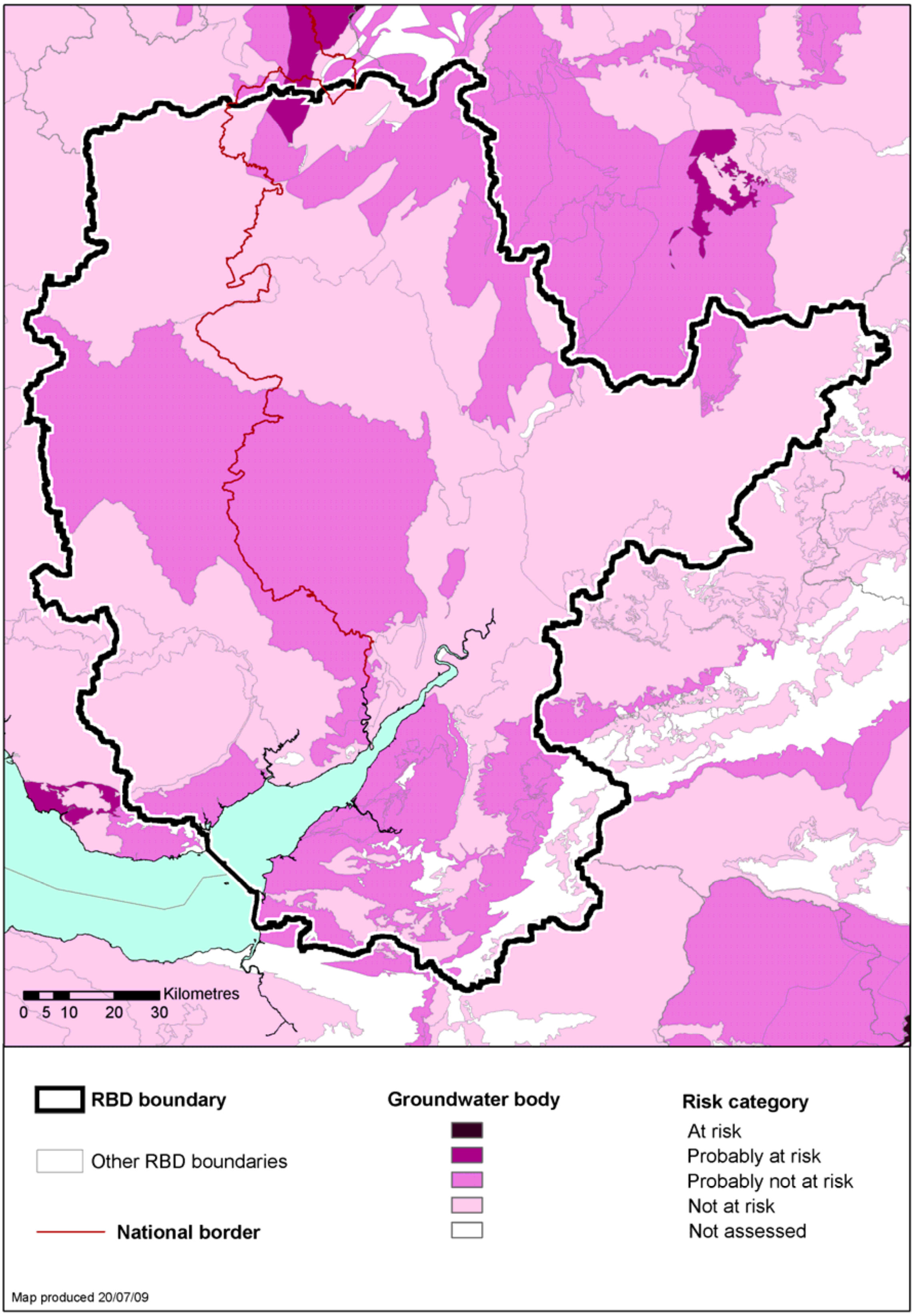


Figure G.4.5: **Abstraction and Flow Regulation - Impact on terrestrial ecosystems (groundwater)**

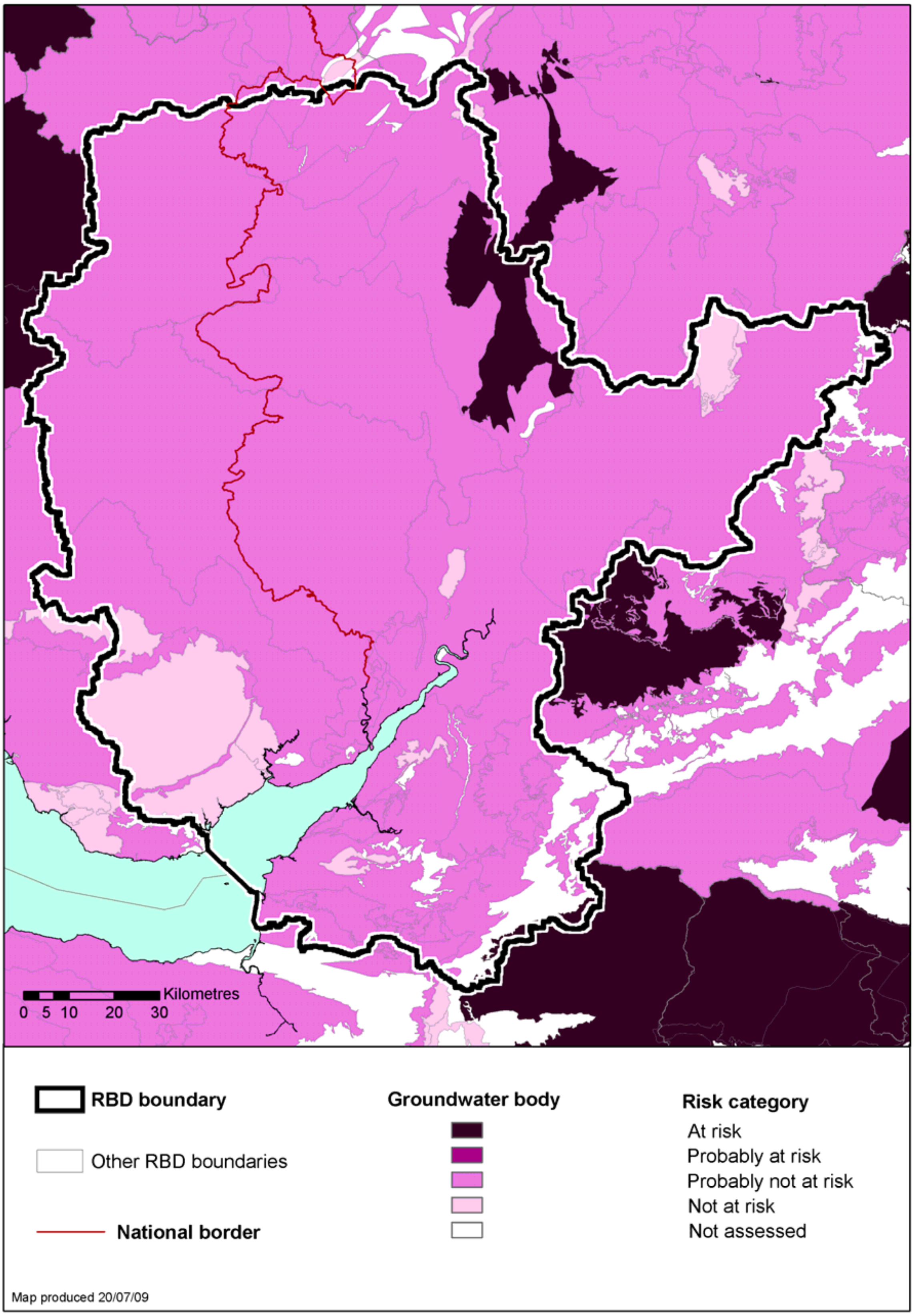


Figure G.4.6: **Abstraction and Flow Regulation - Impact on water balance (groundwater)**

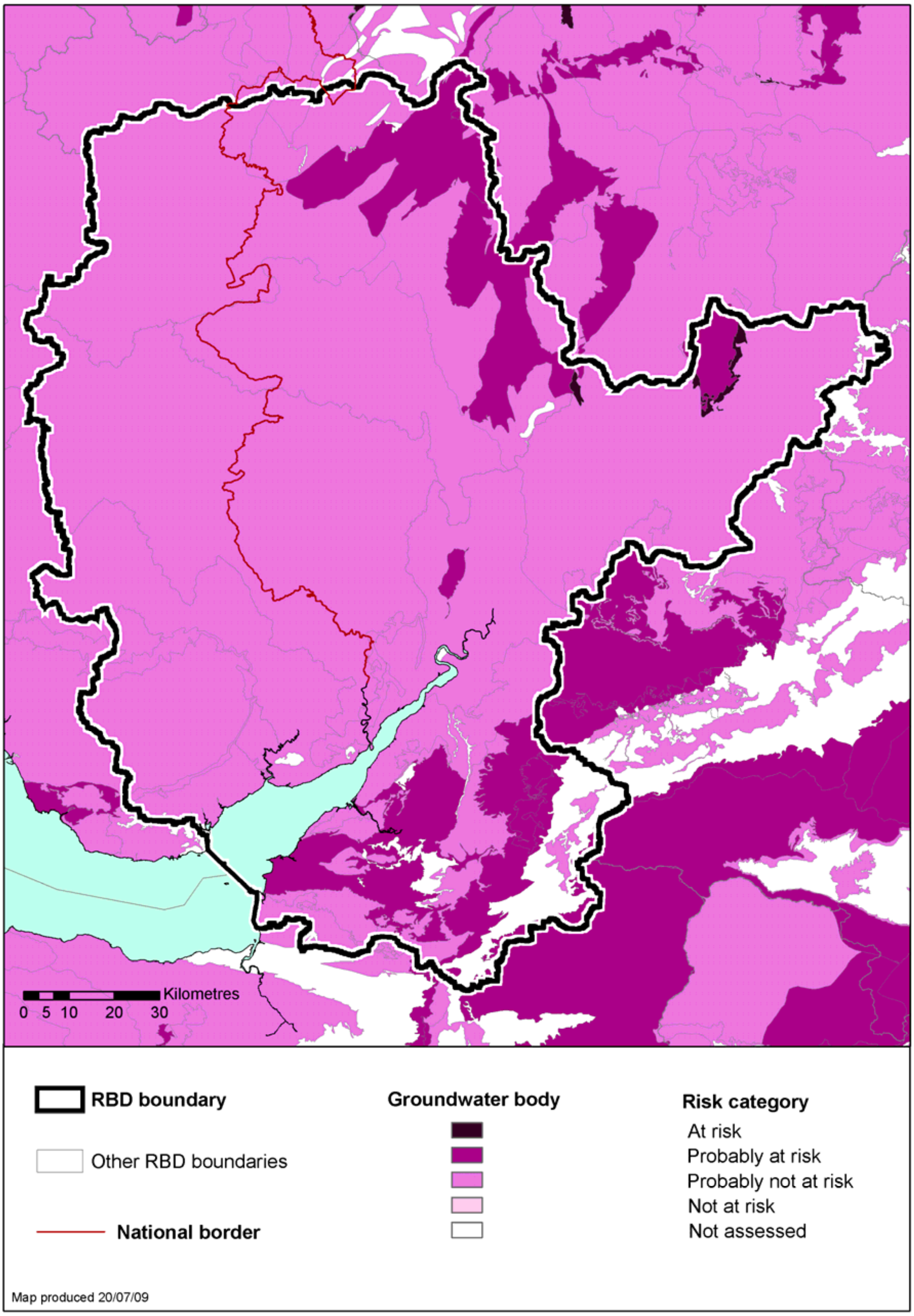


Figure G.4.7: **Invasive non-native species (rivers)**

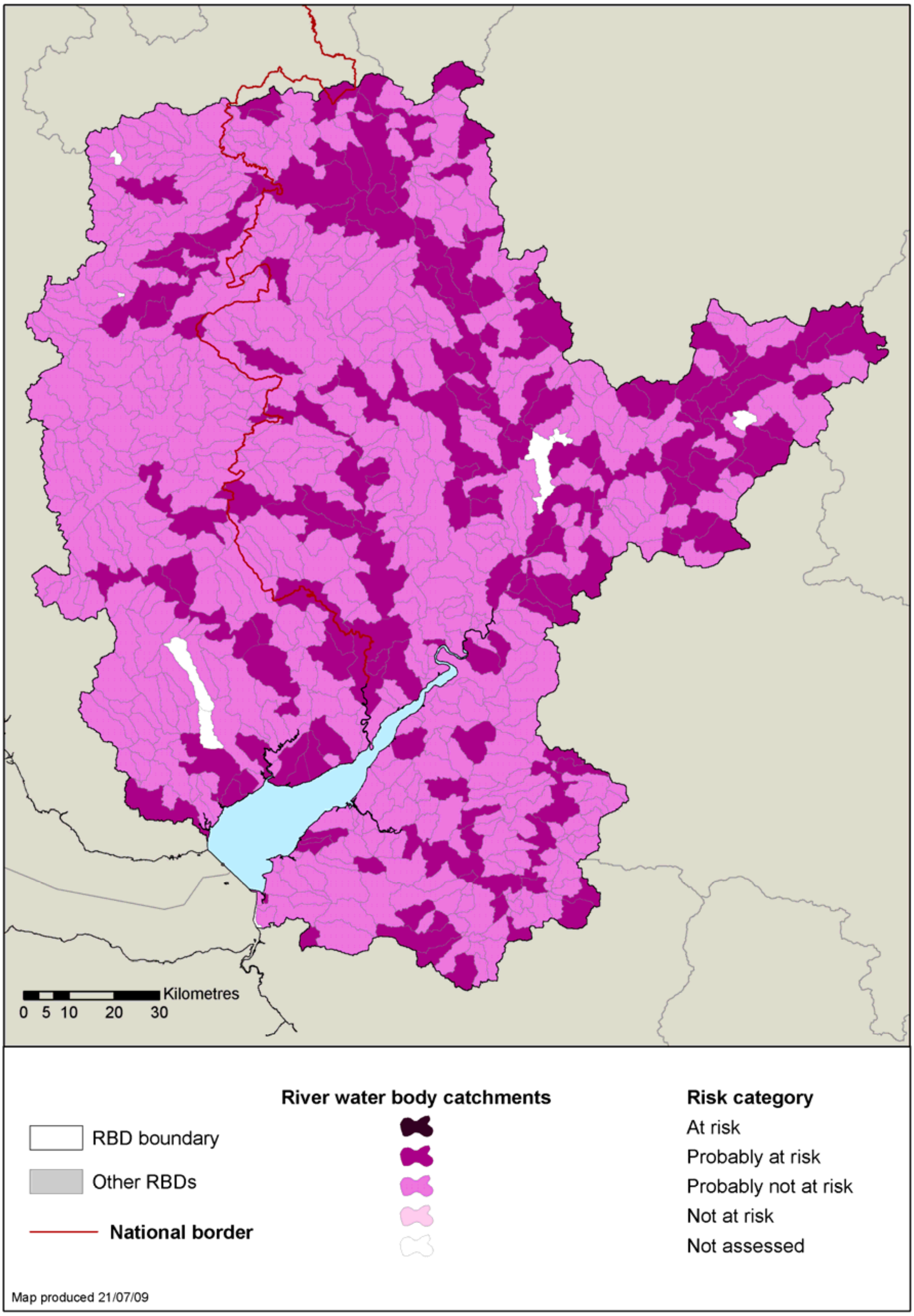


Figure G.4.8: **Invasive non-native species (lakes)**

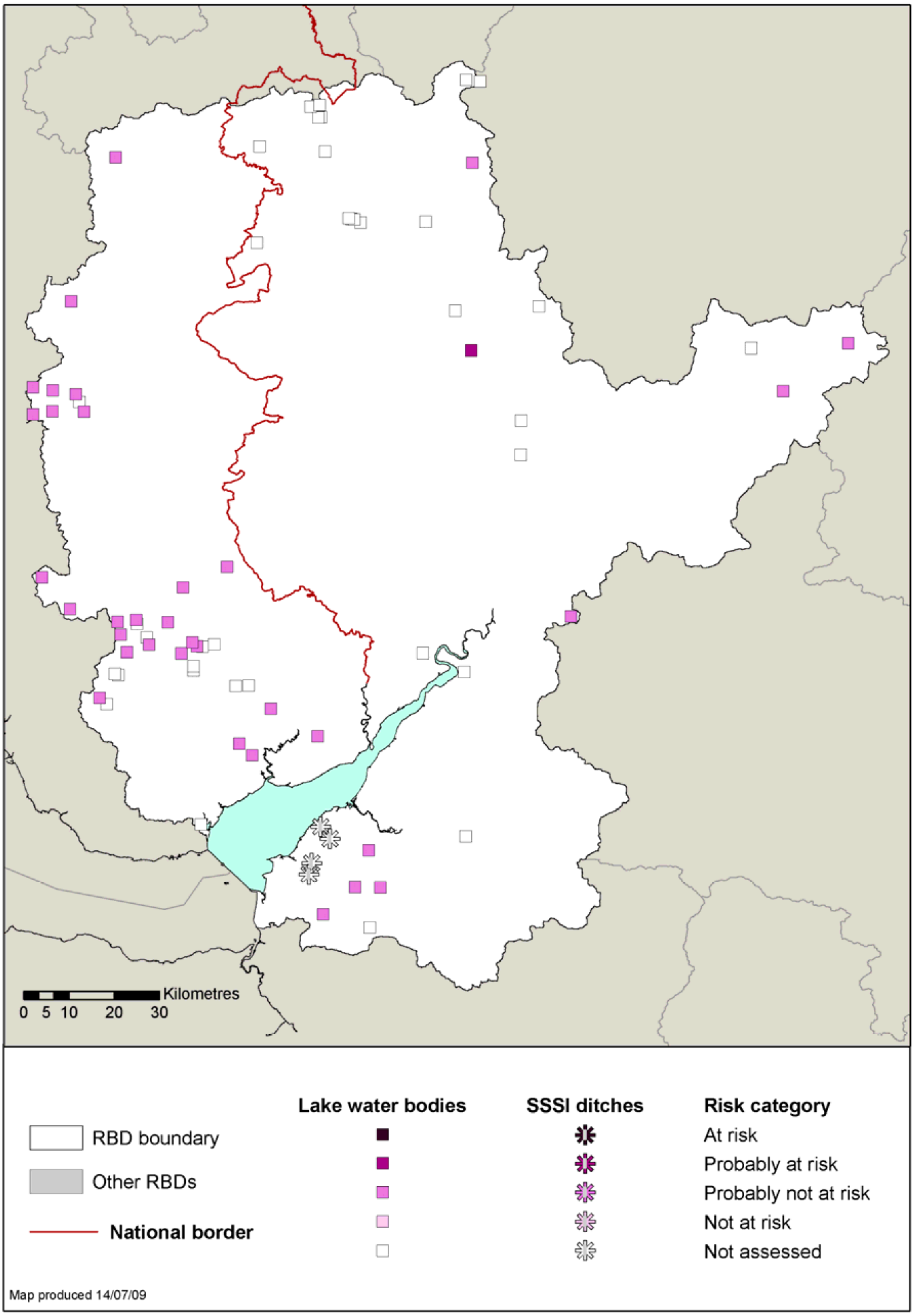


Figure G.4.9: **Invasive non-native species (estuaries and coastal waters)**

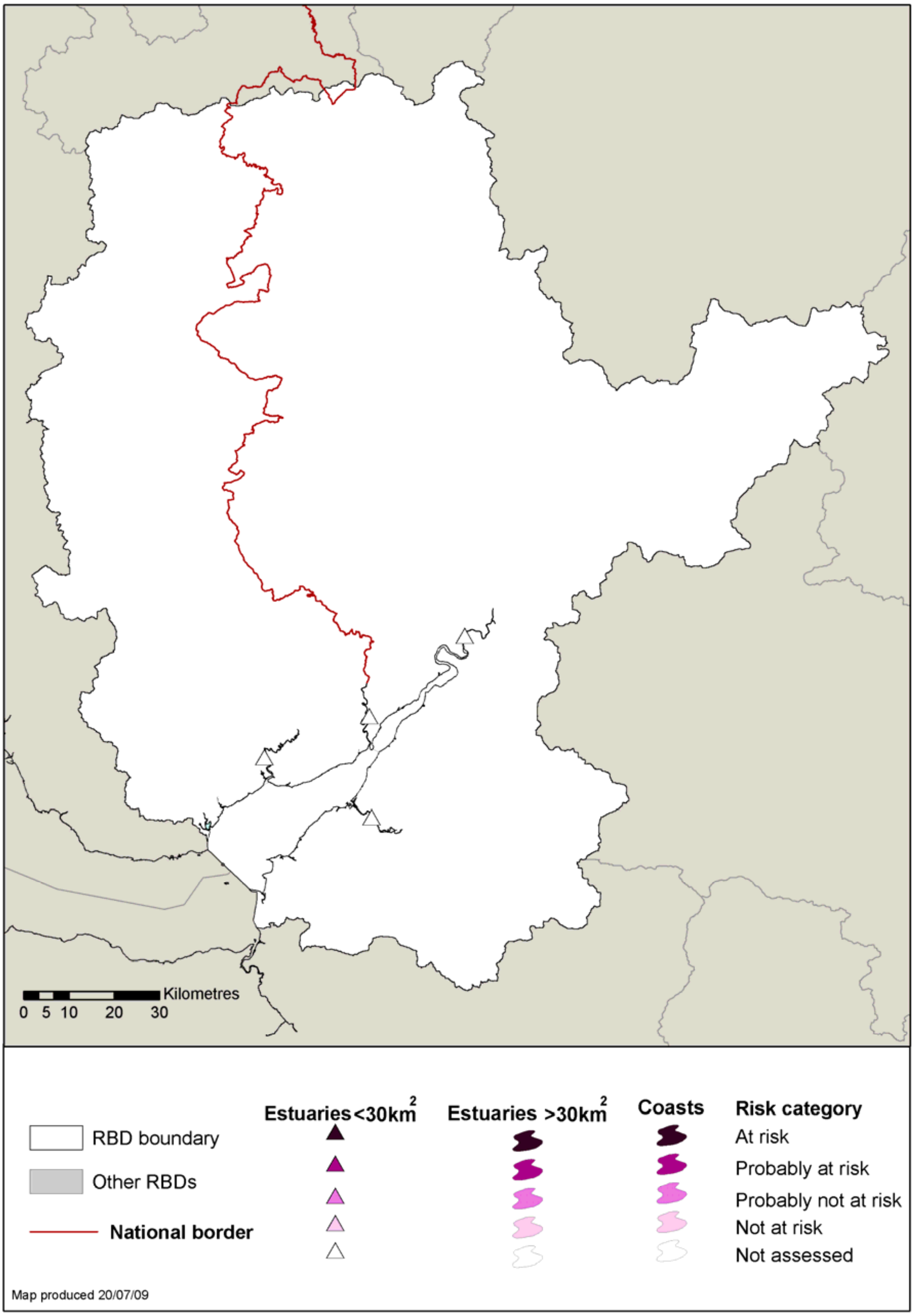


Figure G.4.10: **Combined source pressures - Total oxidised nitrogen (rivers)**

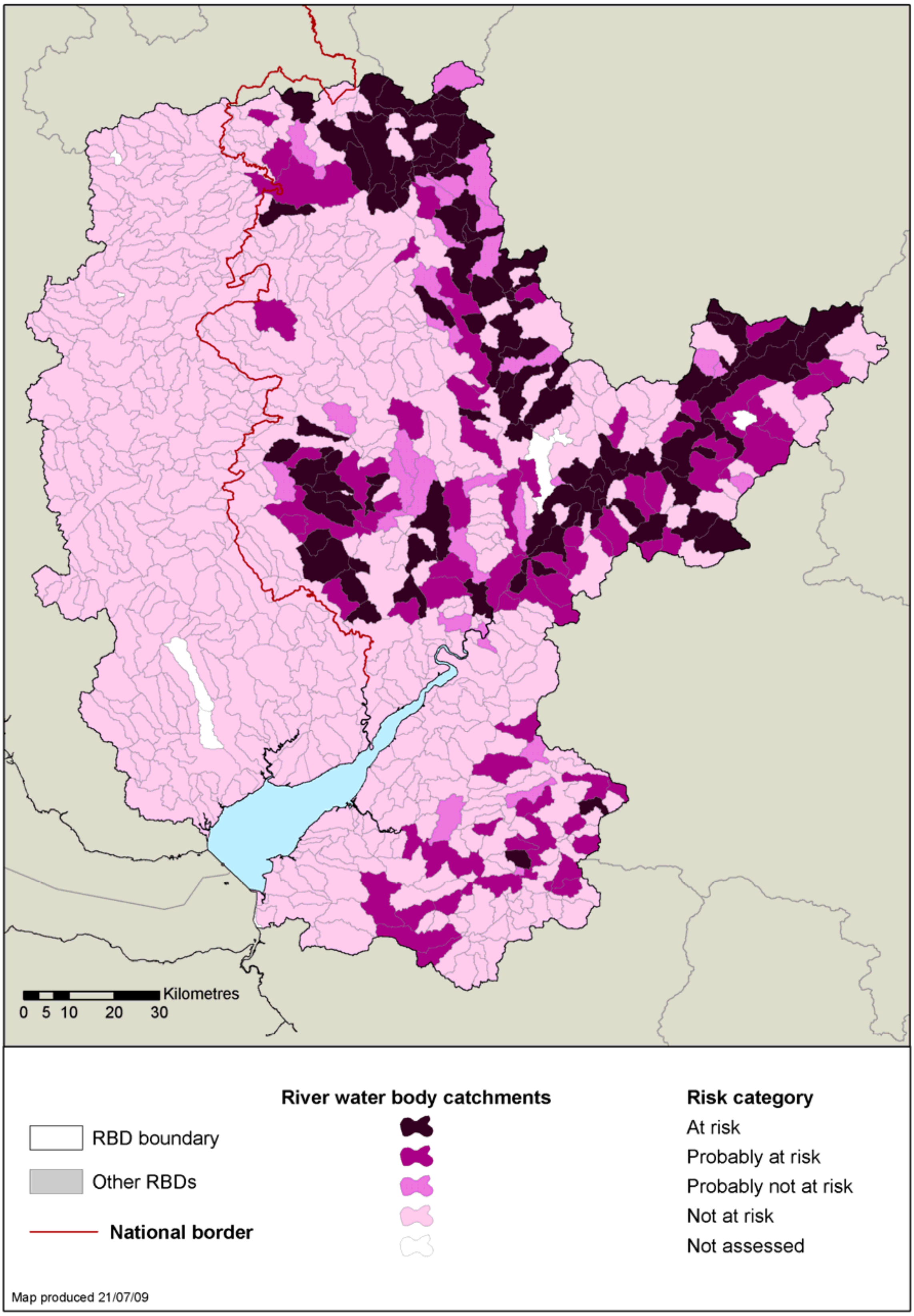


Figure G.4.11: **Nitrates (groundwater)**

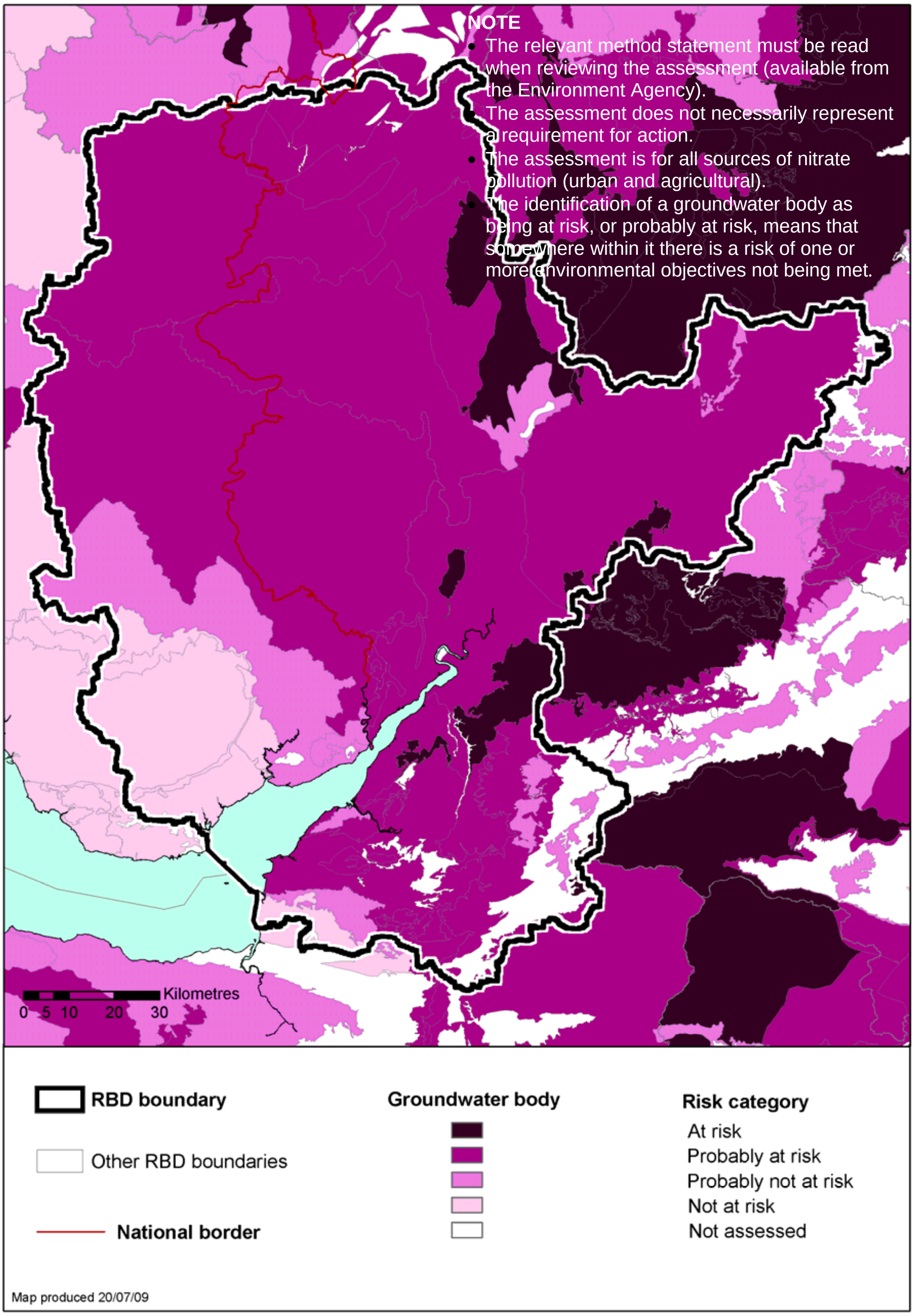


Figure G.4.12: **Upward trend - Nitrate (groundwater)**

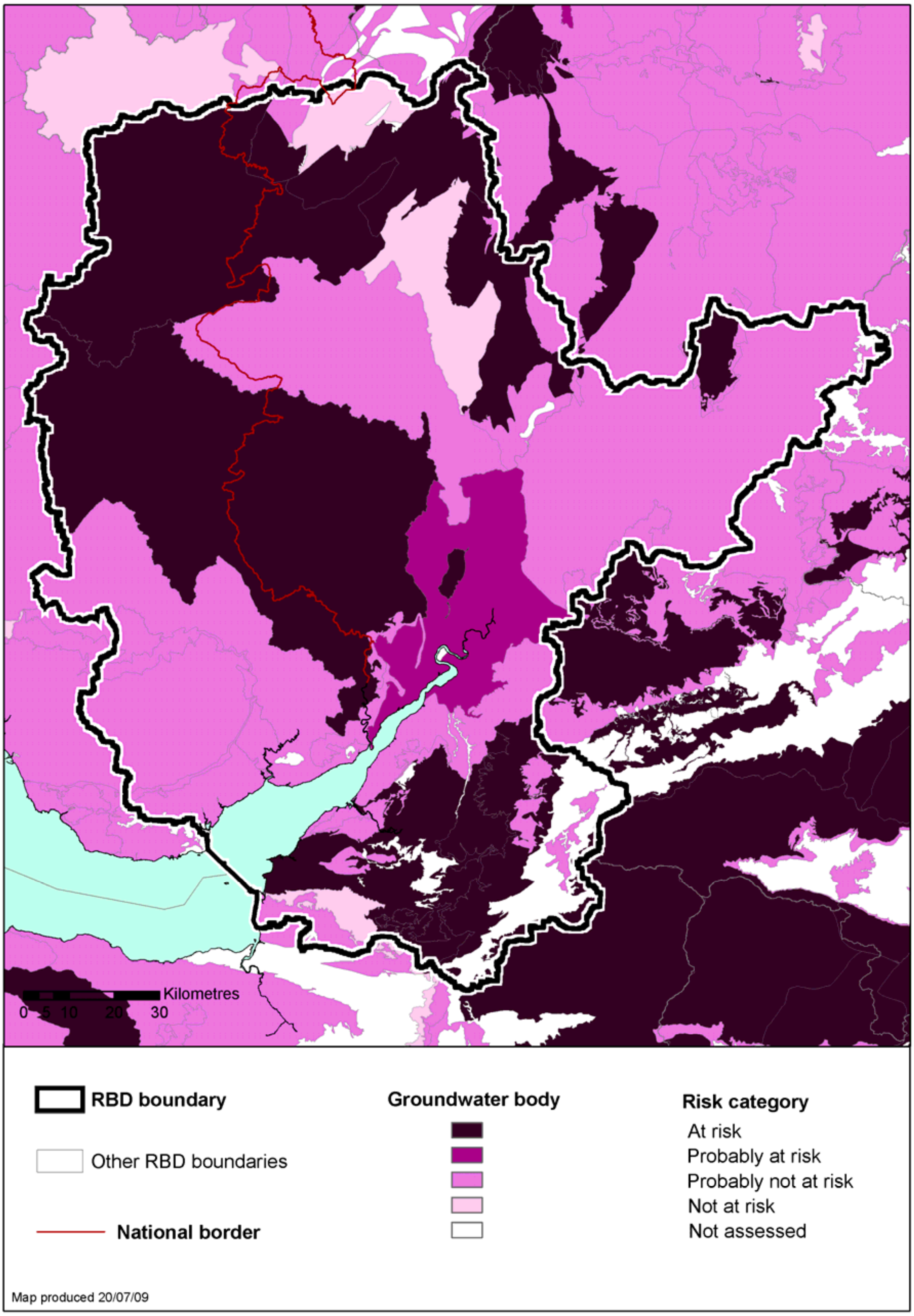


Figure G.4.13: **Risk to Drinking Water Protected Areas (groundwater)**

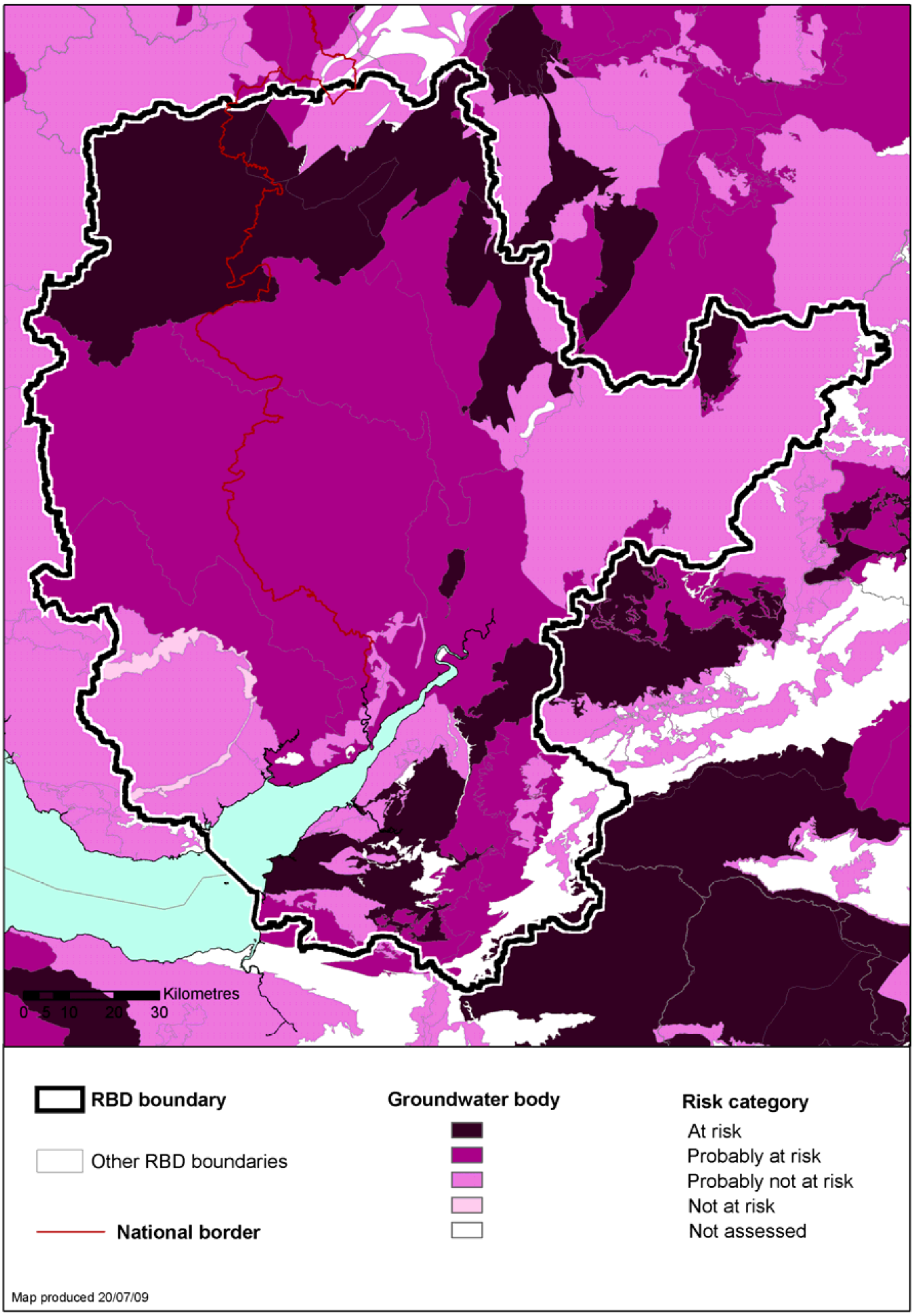


Figure G.4.14: **Diffuse source pressures - agricultural pesticides (river drinking water sources)**

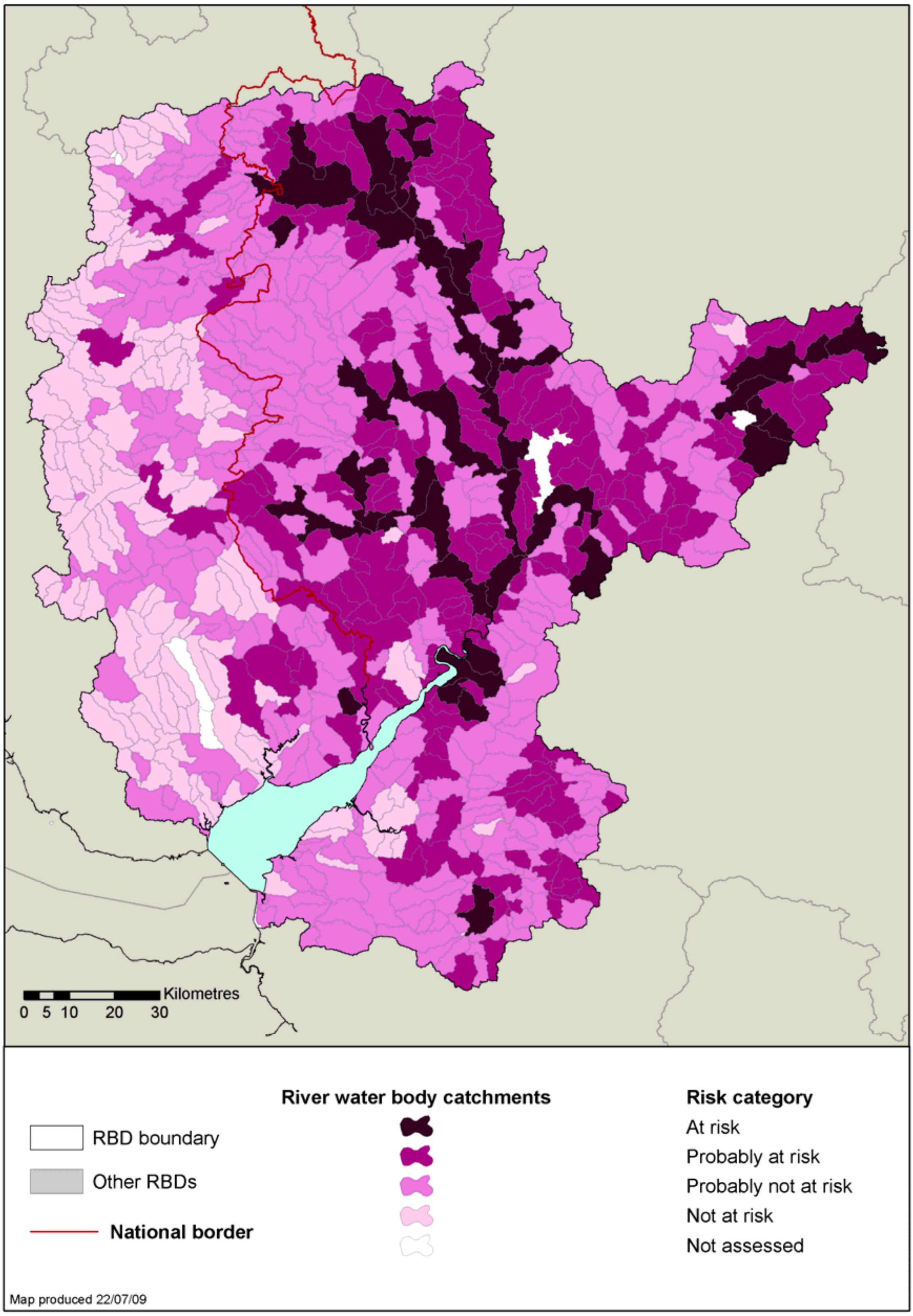


Figure G.4.15: **Diffuse source pressures - sheep dip (rivers)**

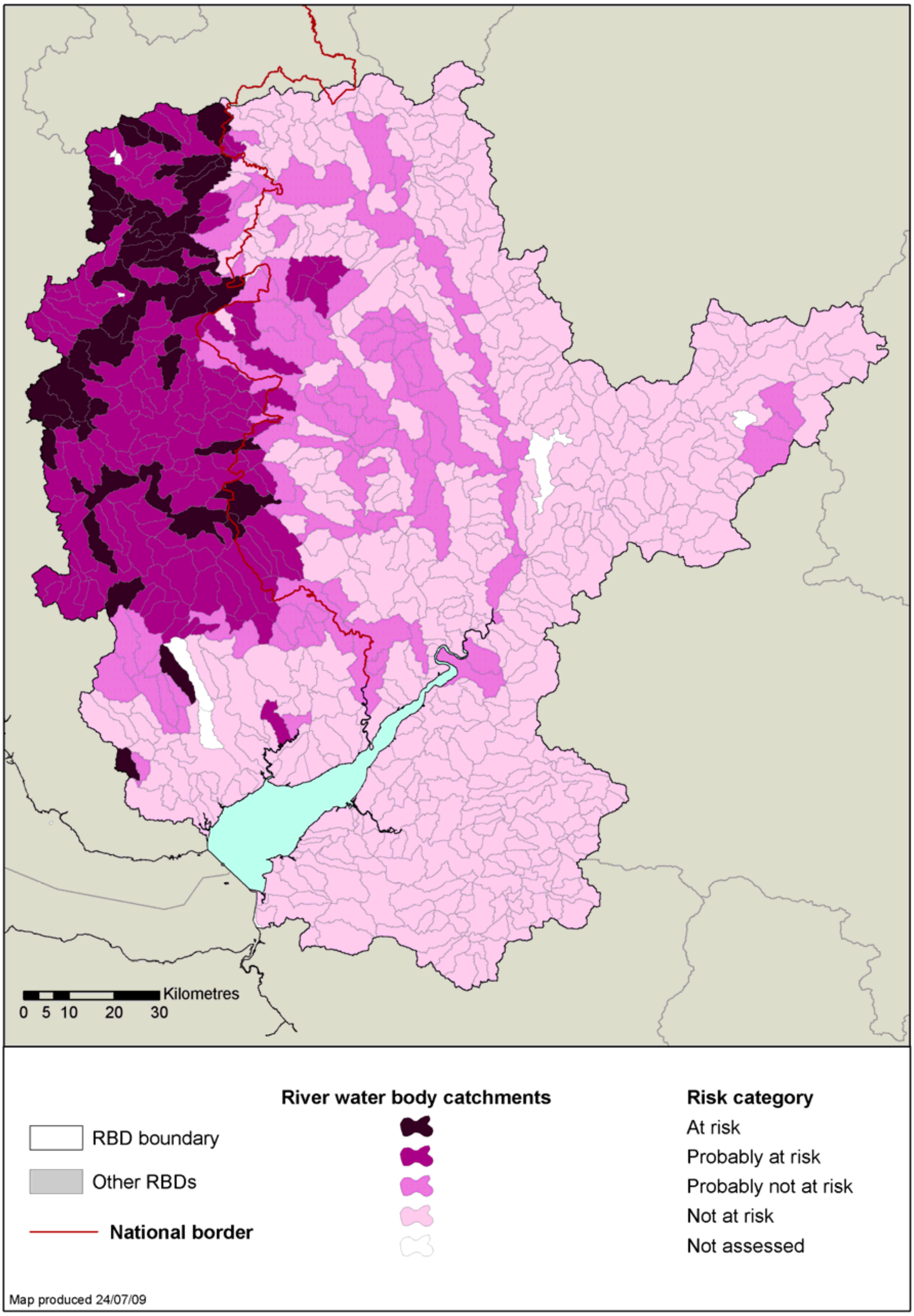


Figure G.4.16: **Point source pressures - pesticides (rivers)**

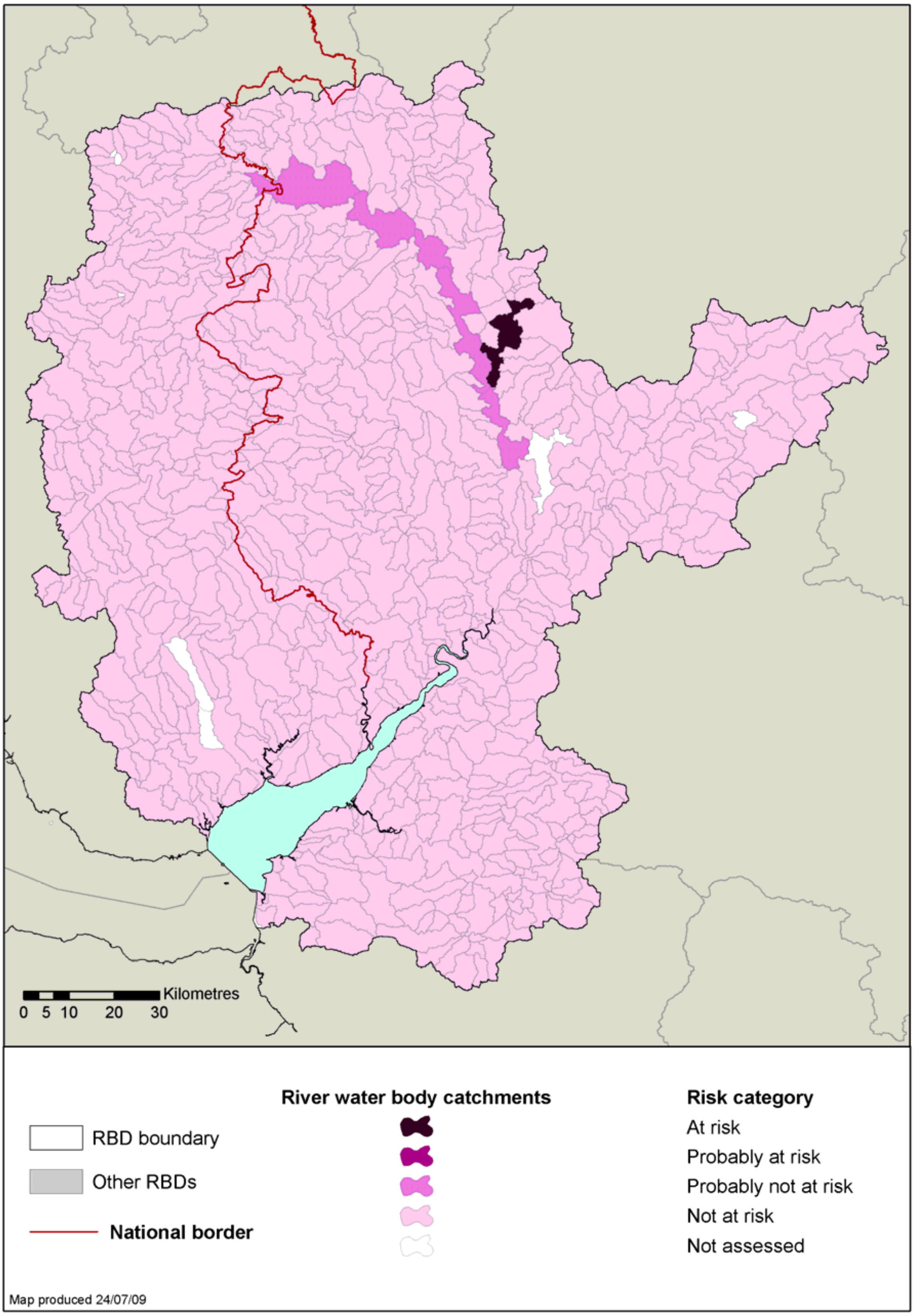


Figure G.4.17: **Diffuse source pressures - pesticides (groundwater)**

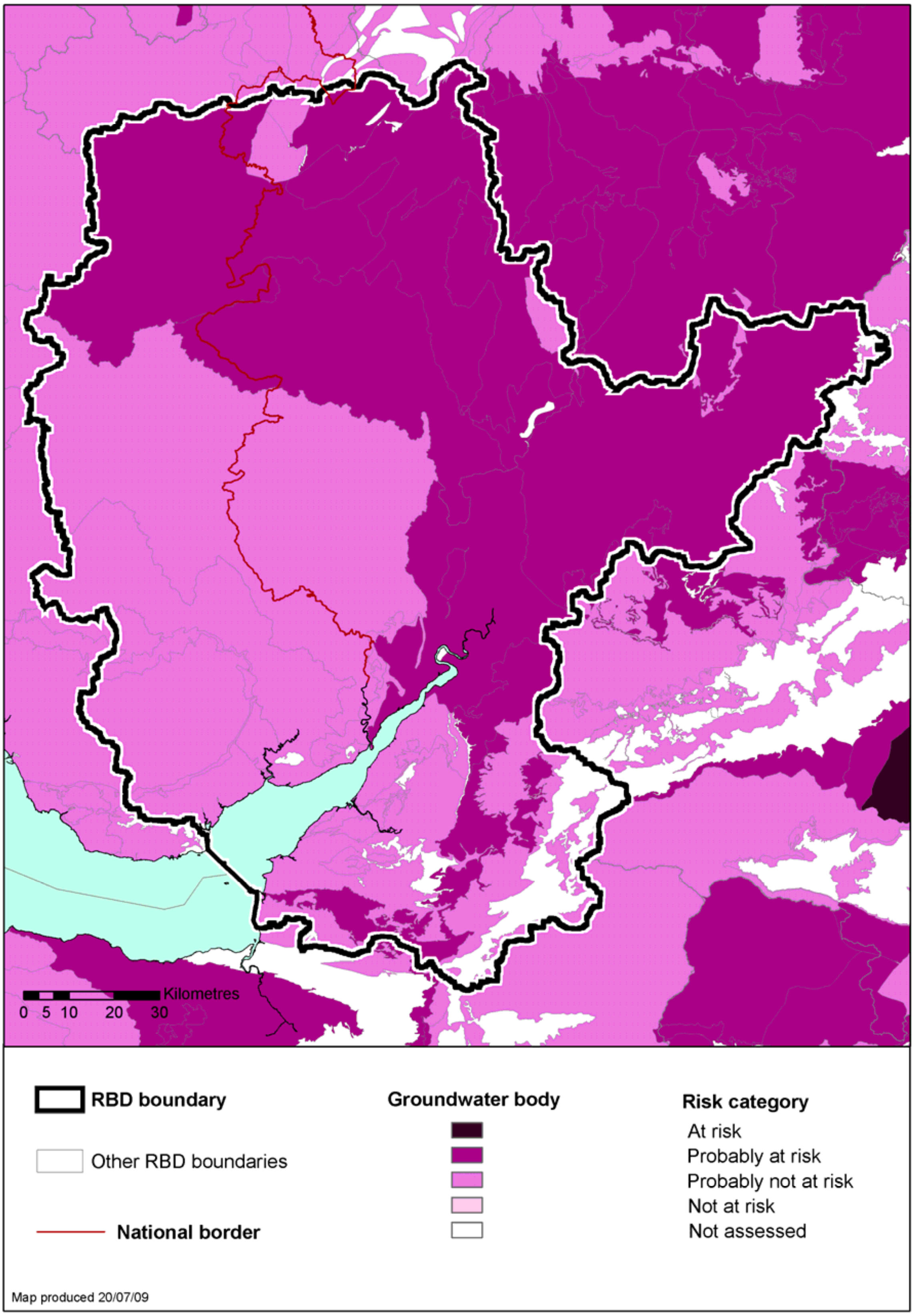


Figure G.4.18: **Diffuse source pressures - phosphate (groundwater)**

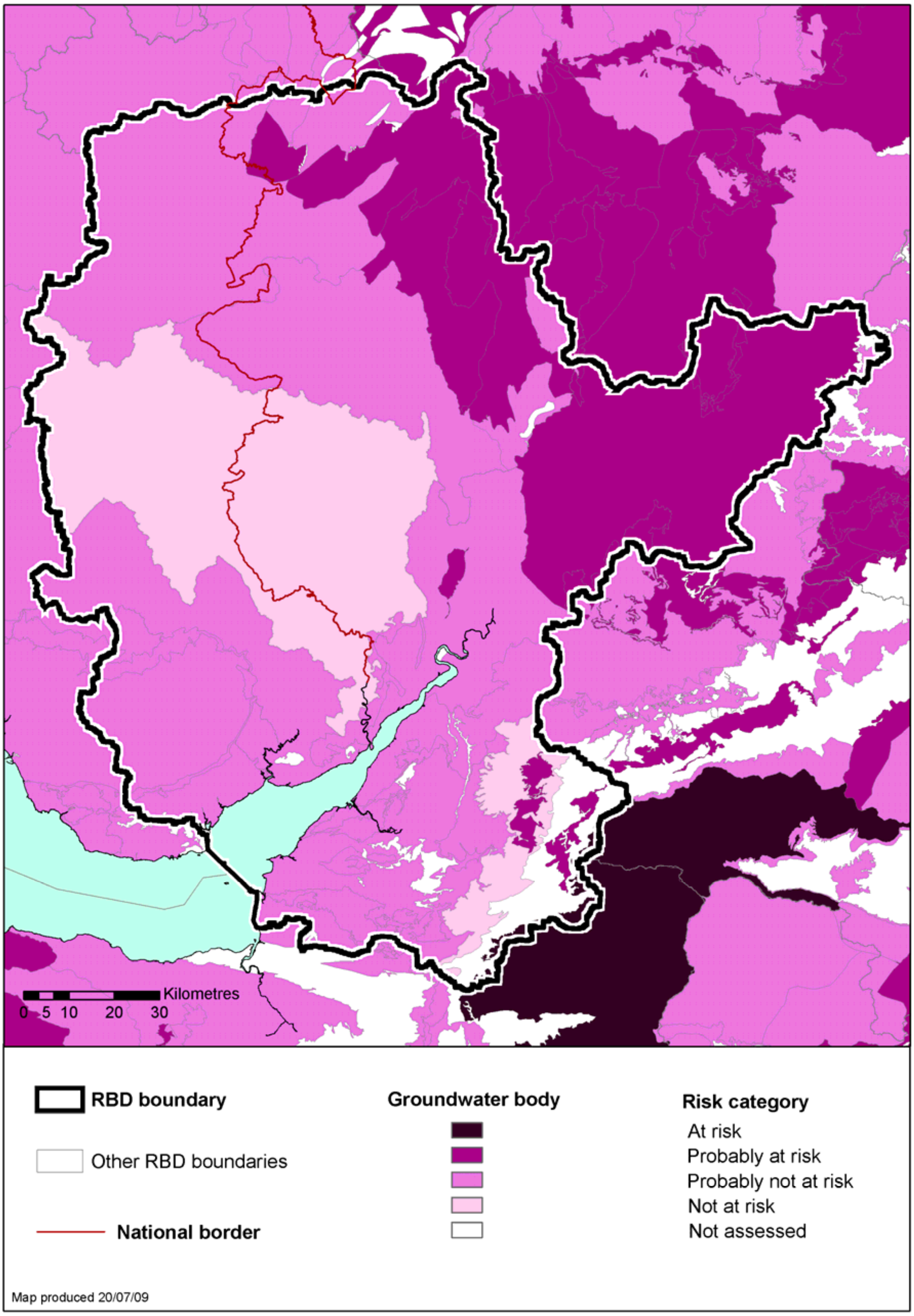


Figure G.4.19: **Combined source pressures - phosphorus (rivers)**

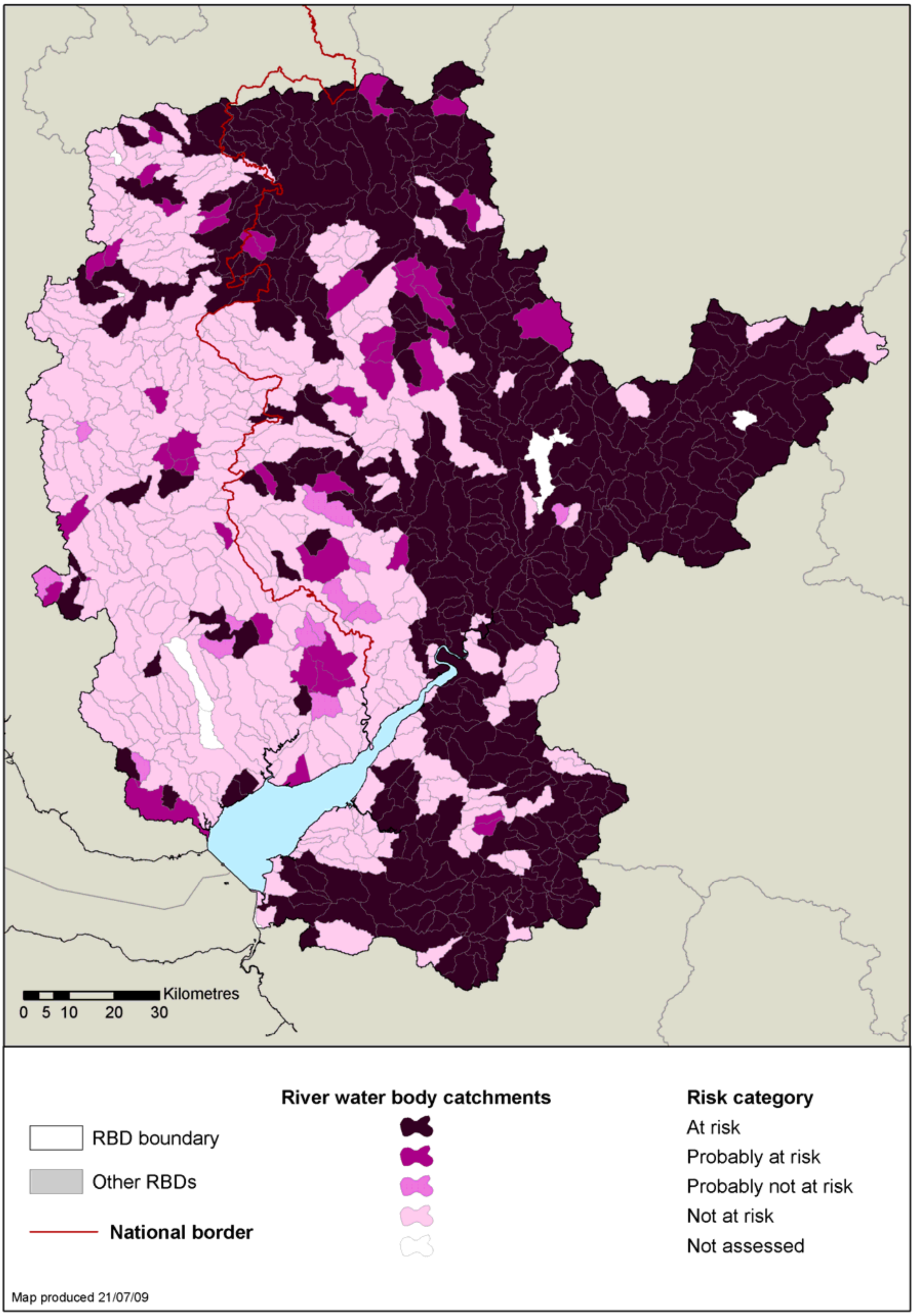


Figure G.4.20: **Diffuse source pressures - phosphorus from agriculture (rivers)**

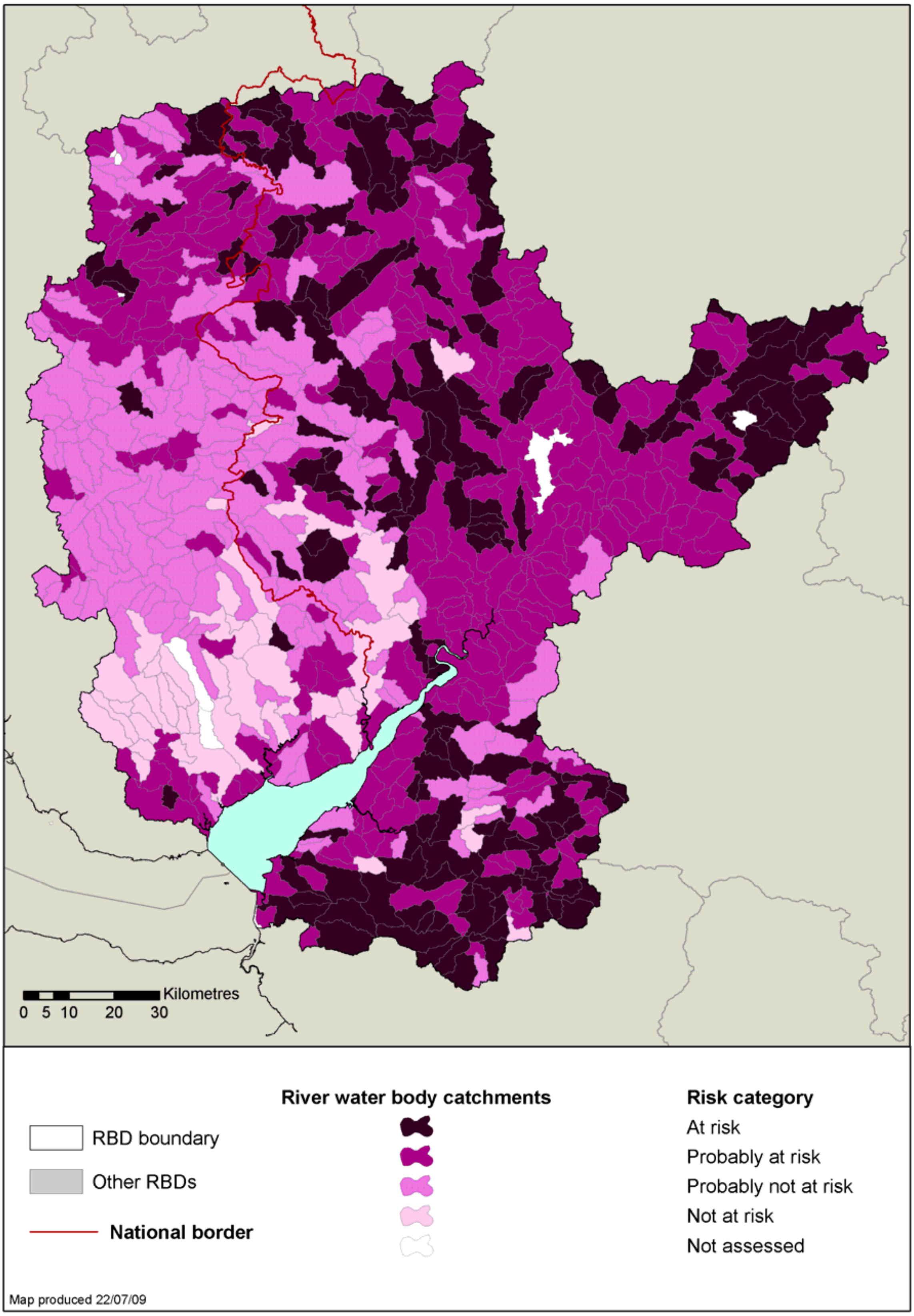


Figure G.4.21: **Physical or morphological alteration (estuaries and coastal waters)**

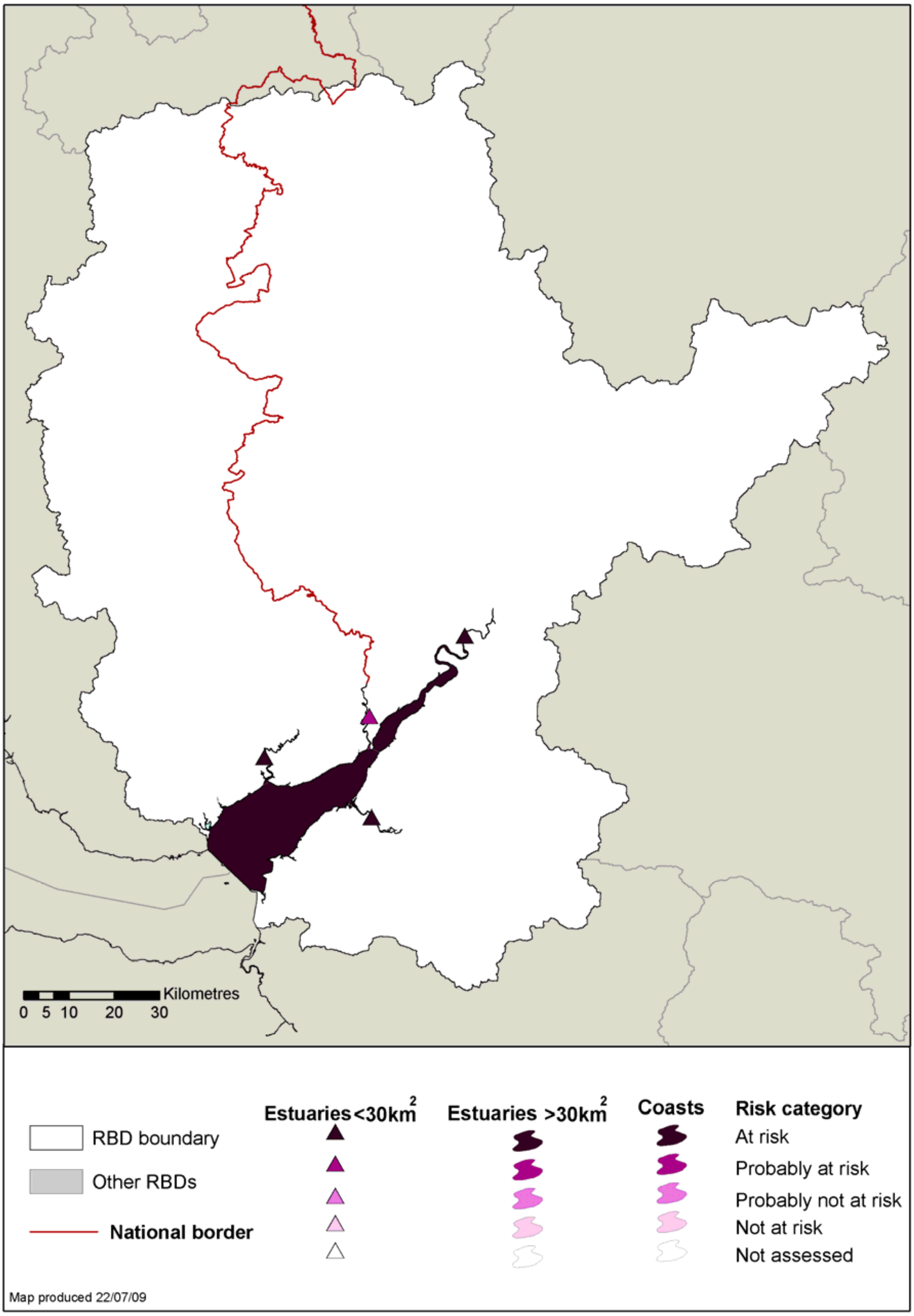


Figure G.4.22: **Physical or morphological alteration (rivers)**

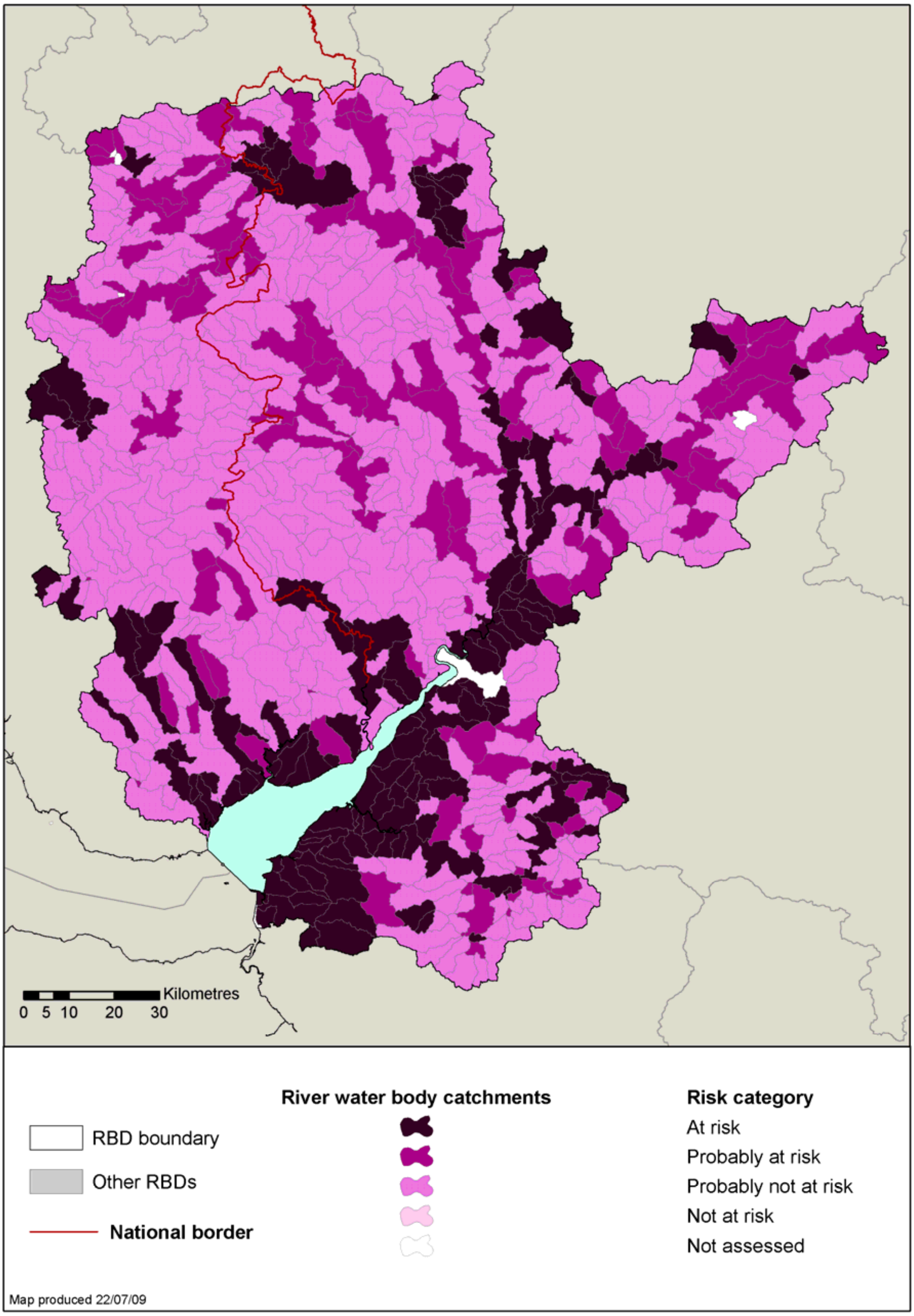


Figure G.4.23: **Physical or morphological alteration (lakes)**

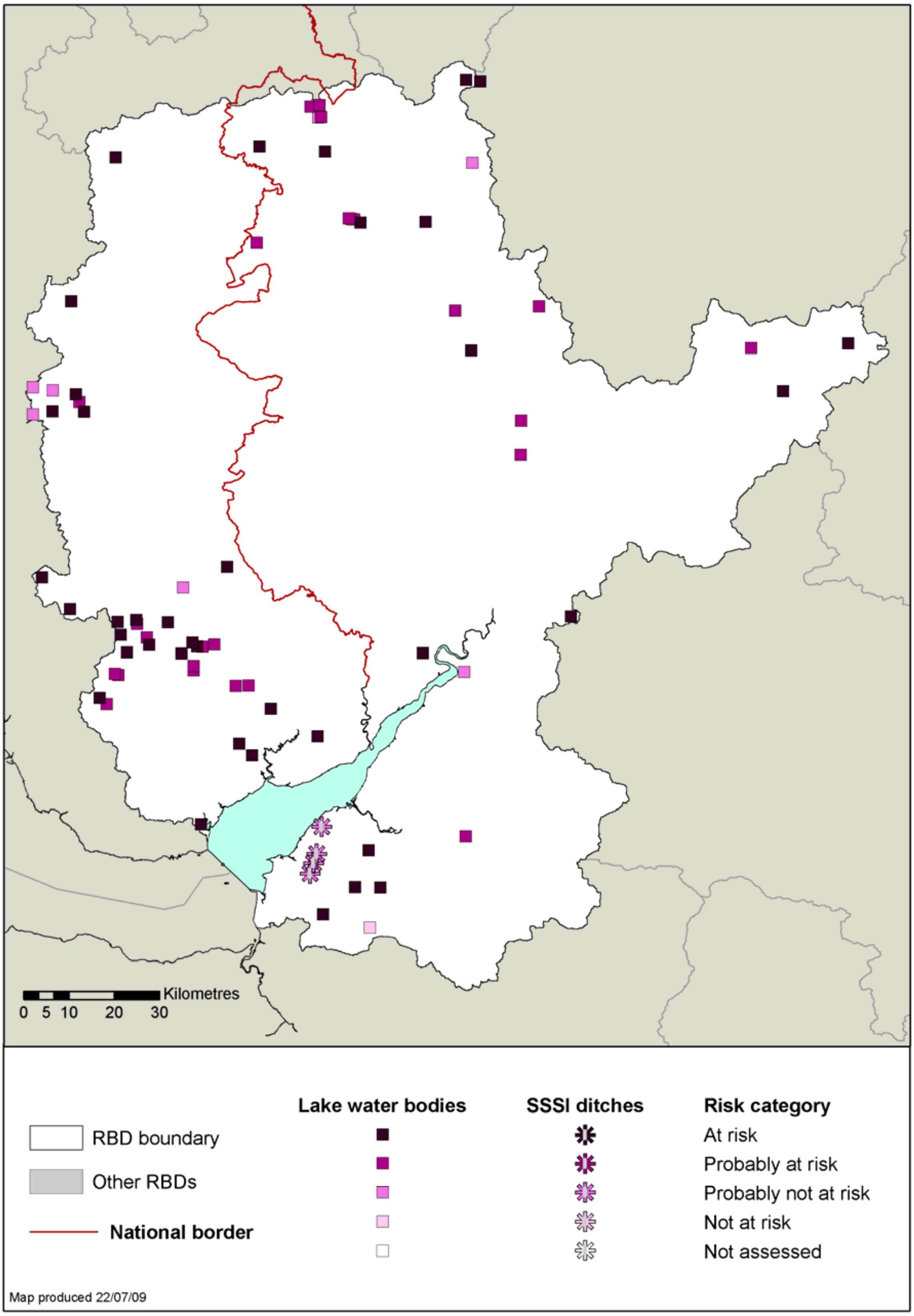


Figure G.4.24: **Diffuse source pressures – sediment (rivers)**

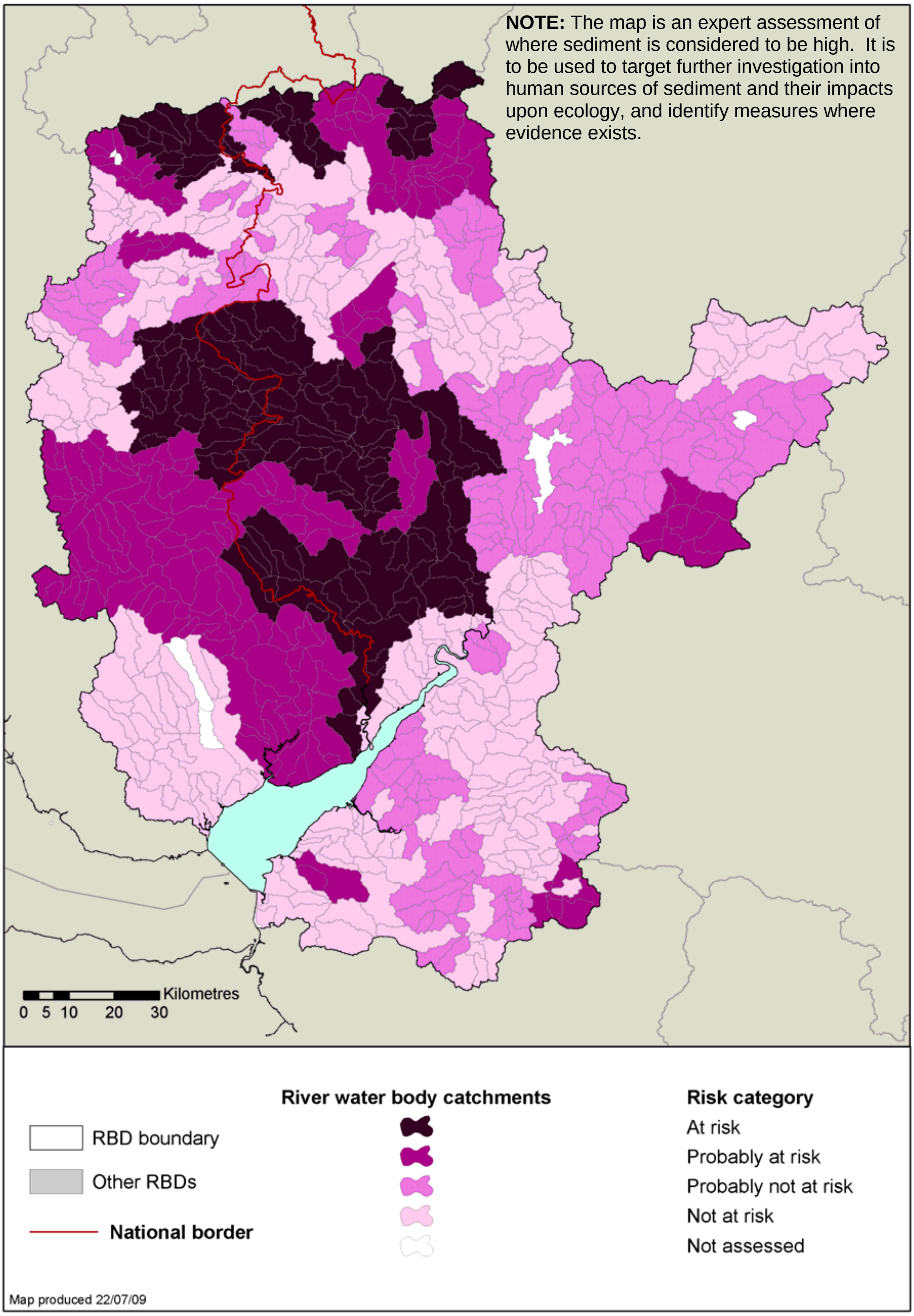


Figure G.4.25: **Diffuse source pressures – acidification (rivers)**

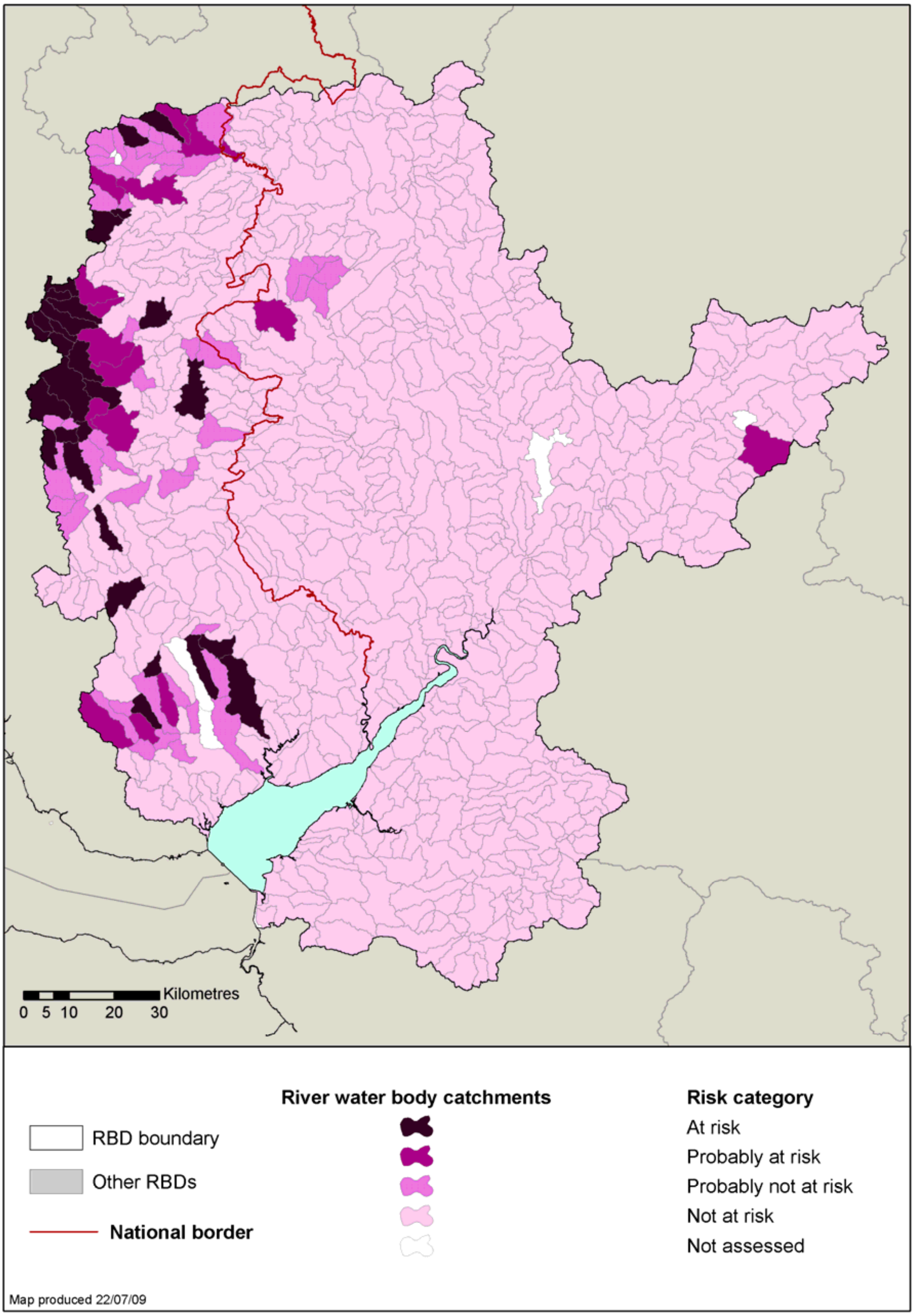


Figure G.4.26: **Diffuse source pressures - mines and minewaters (rivers)**

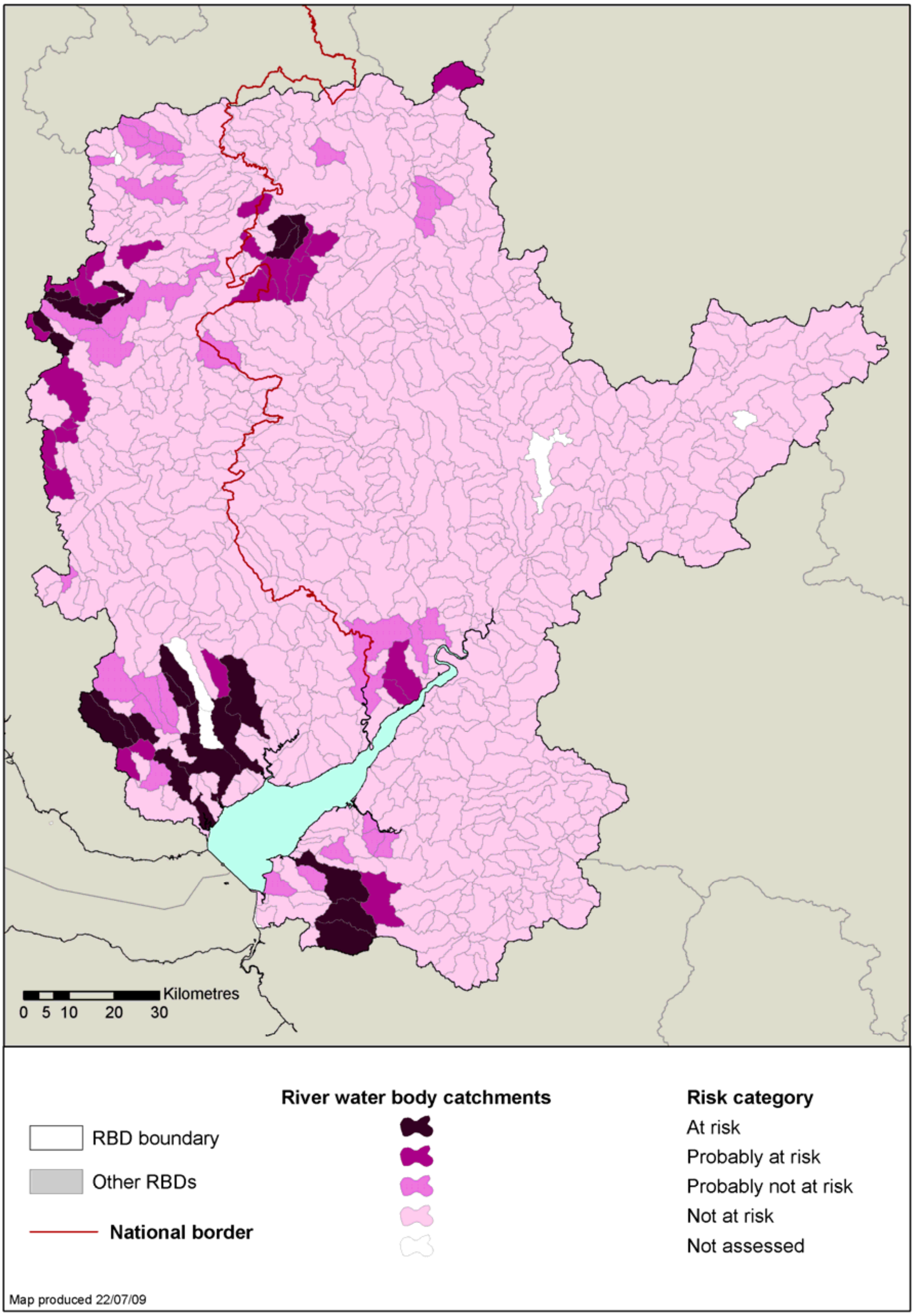


Figure G.4.27: **Diffuse source pressures - mines and minewaters (groundwater)**

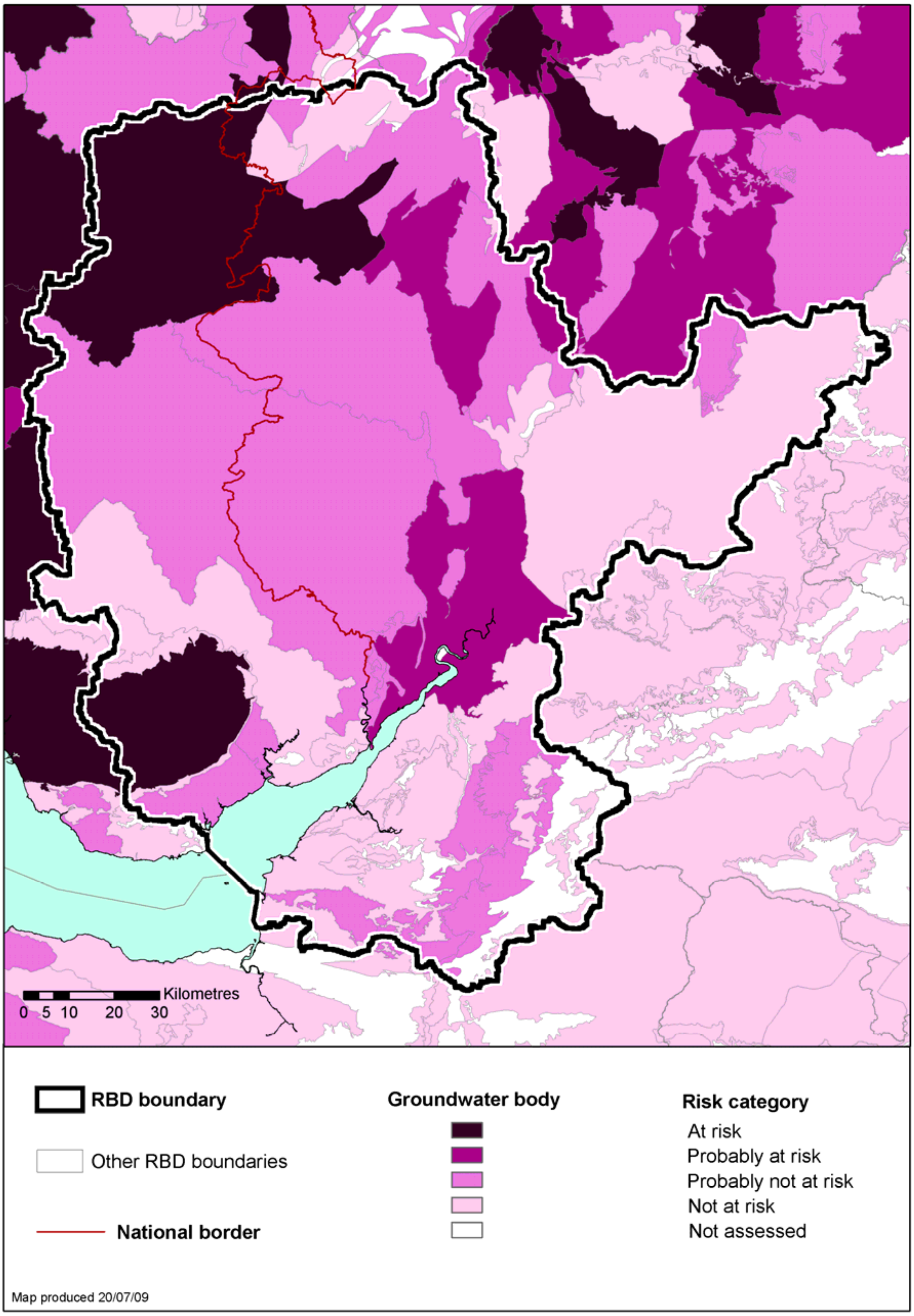


Figure G.4.28: **Combined source pressures - ammonia (rivers)**

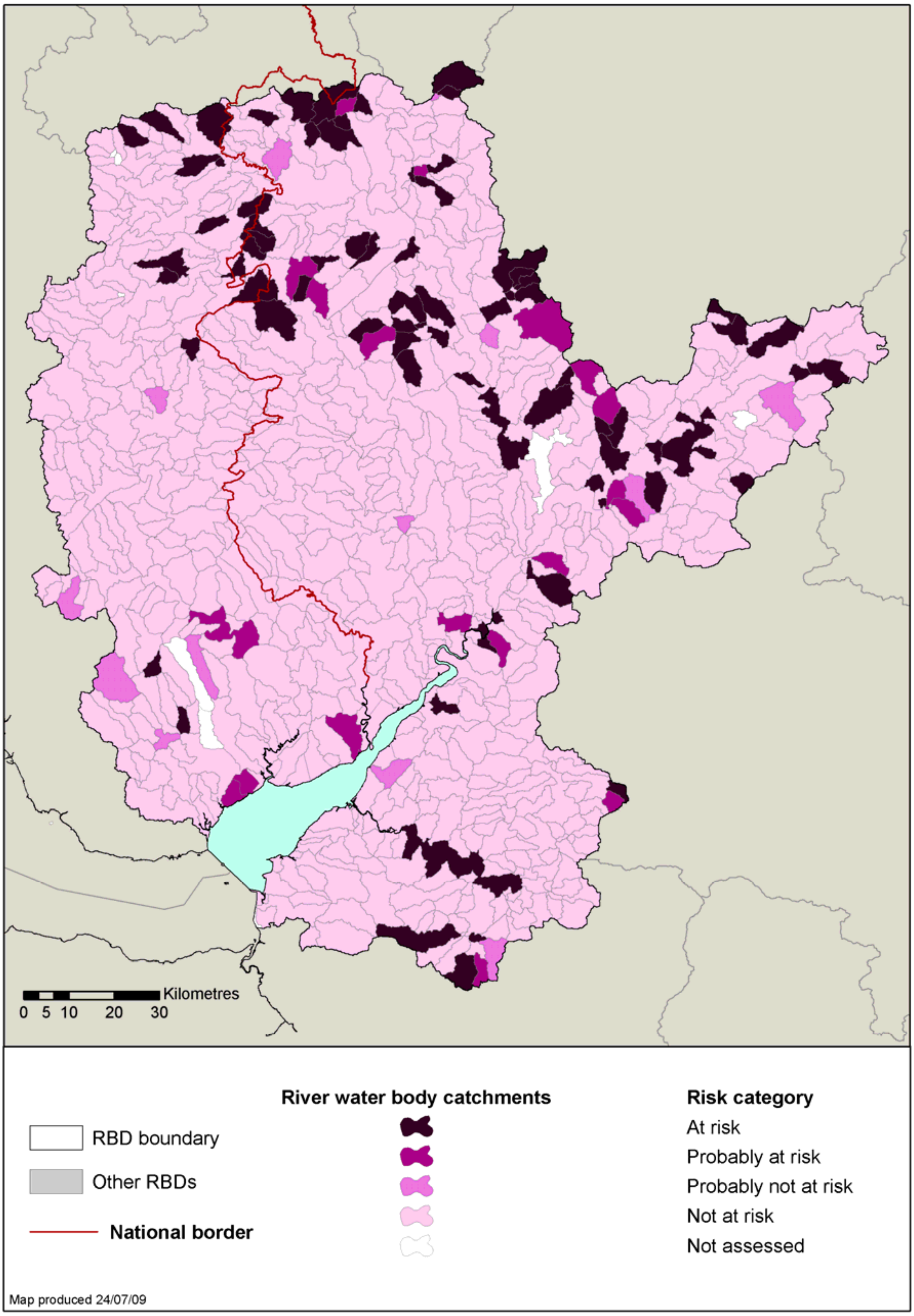


Figure G.4.29: **Combined source pressure - biochemical oxygen demand (rivers)**

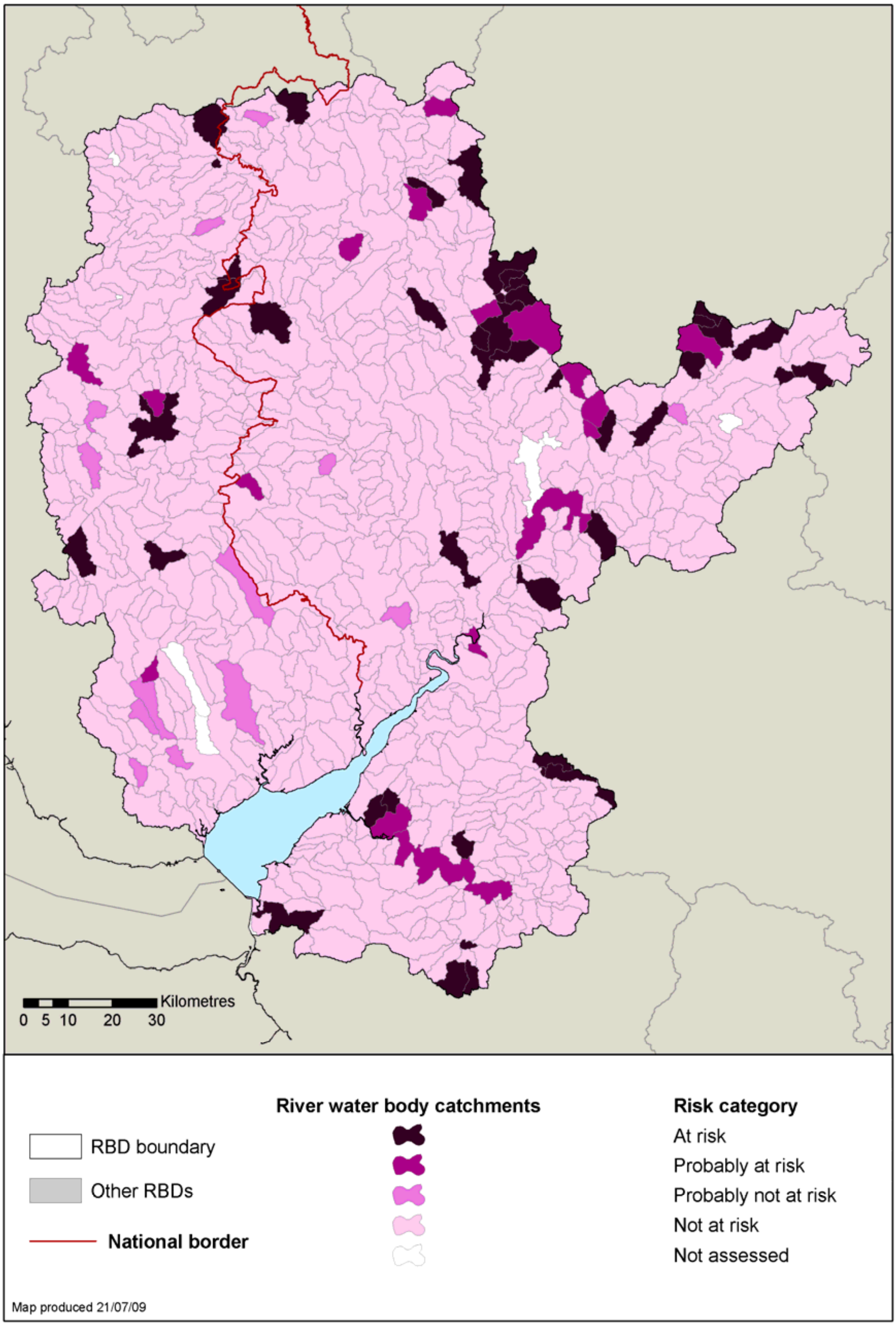


Figure G.4.30: **Point source pressures - metals (rivers)**

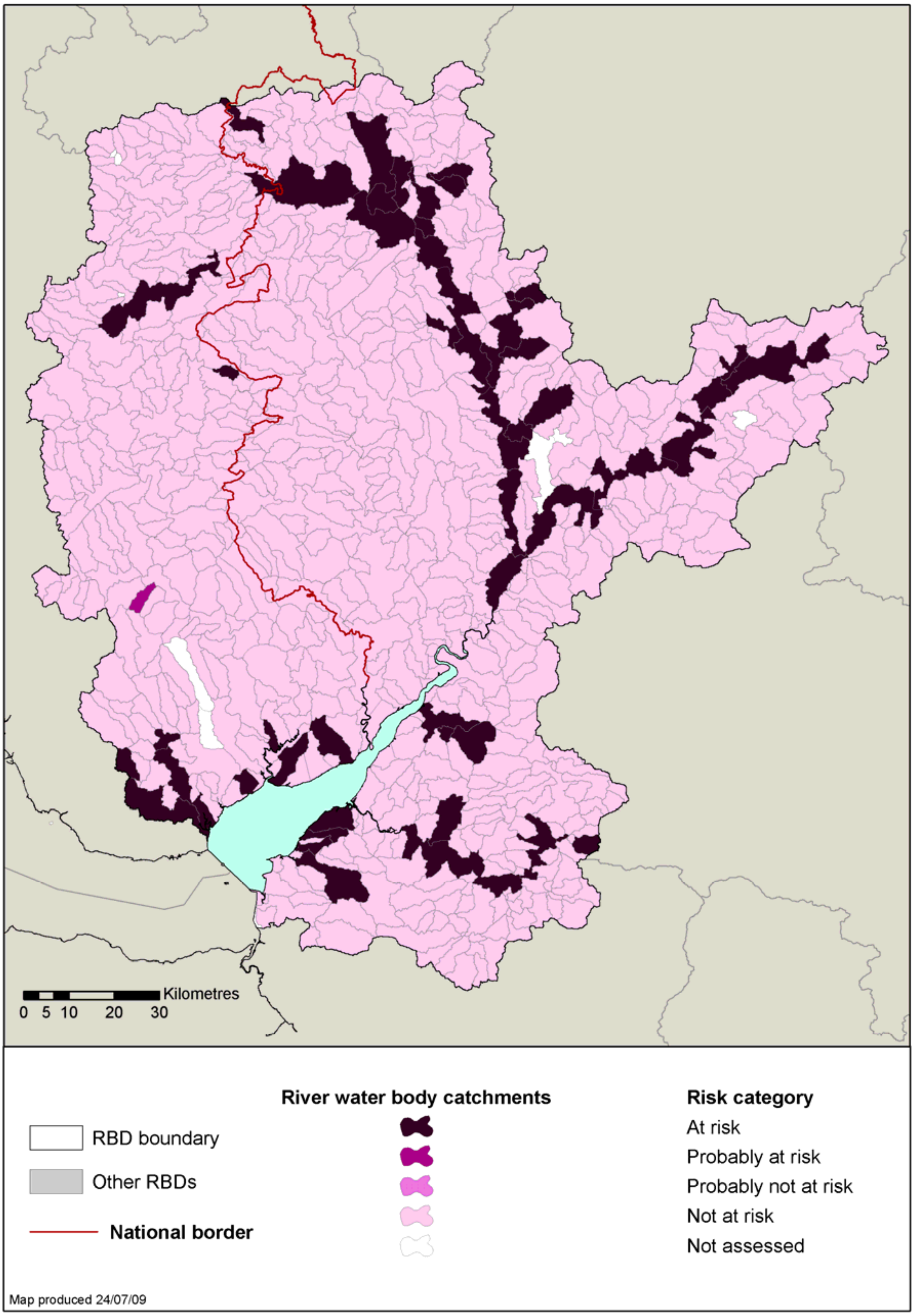


Figure G.4.31 : **Point source pressures - Dangerous Substances Directive compliance (rivers)**

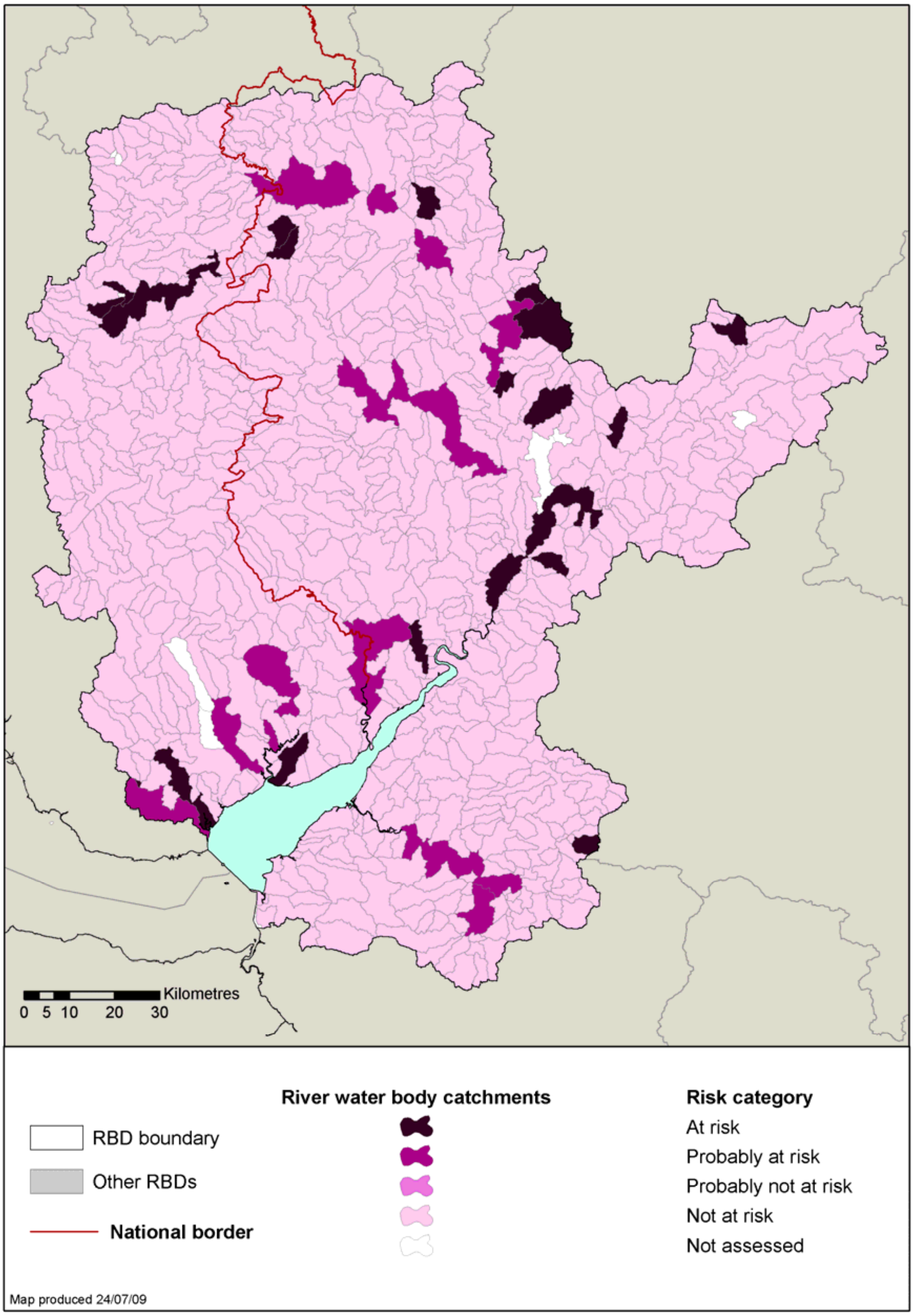


Figure G.4.32: **Hazardous substances (not including pesticides) (groundwater)**

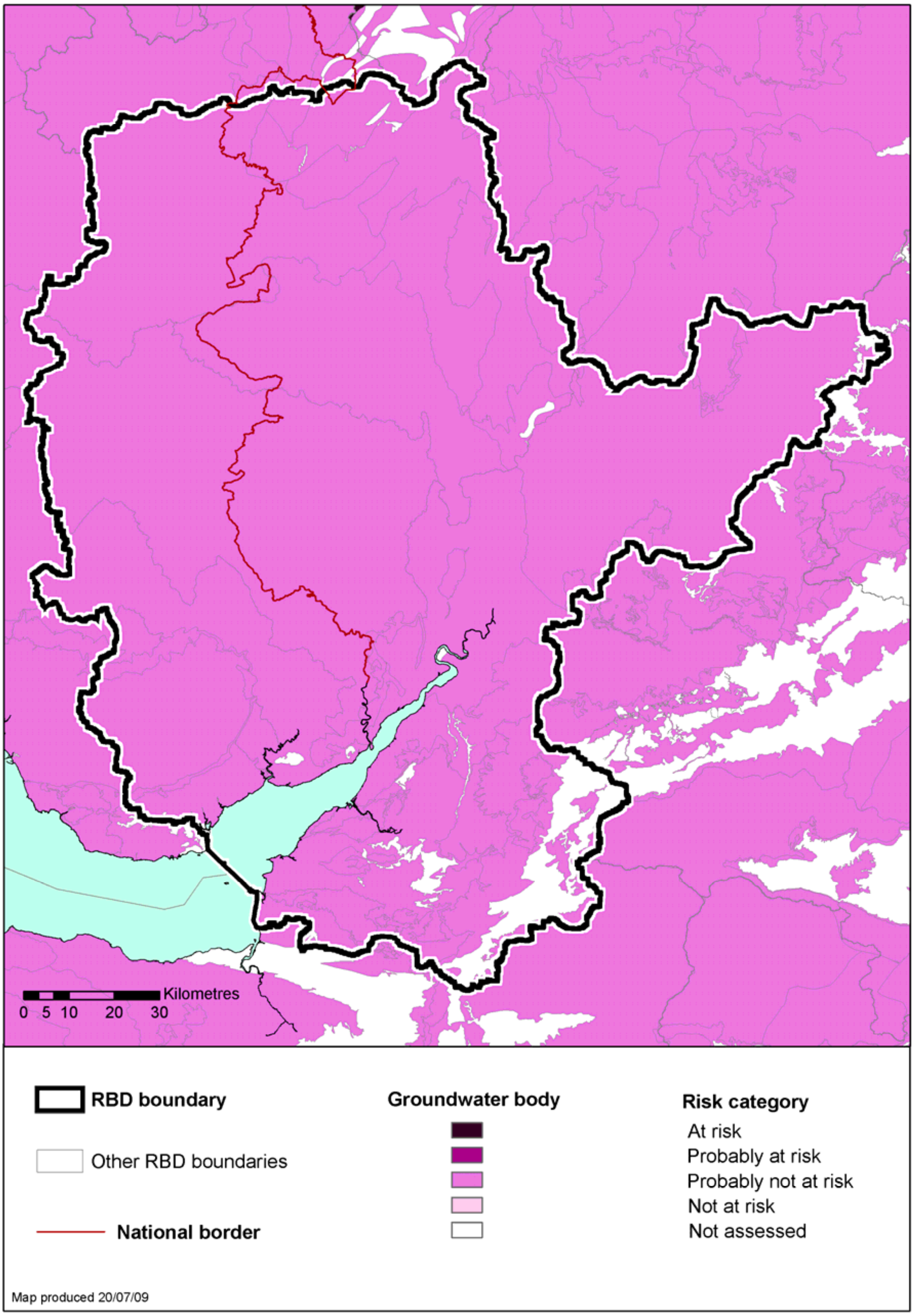
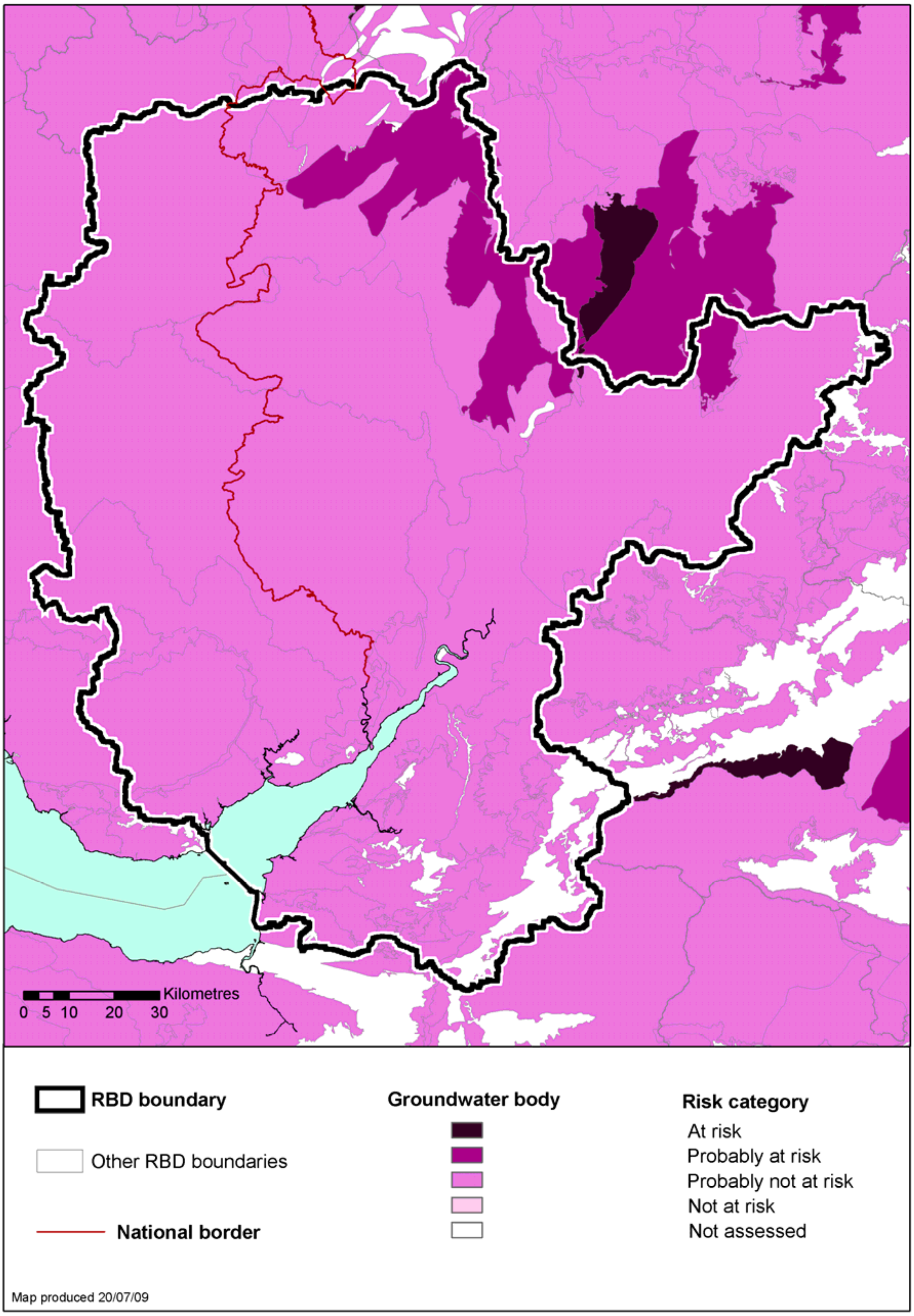


Figure G.4.33: **Chlorinated solvents (groundwater)**



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