Chapter 9
Current Water Quality Risk Areas for Limpopo, Olifants and the Inkomati-Usuthu WMAs

Focus is placed on the northern WMAs of South Africa which include the Limpopo, Olifants as well as the Inkomati-Usuthu WMAs. The Limpopo, Olifants and Inkomati-Usuthu WMAs were all found to be predominantly of low risk in terms of the selected physical and chemical water quality parameters but of concerningly high risk in terms of *Chlorophyll a* and *Faecal coliform*.

Significant risk areas were, however, established for all of the WMAs and directly correlate with the extent of modification of water sources or areas. Significant risk areas were predominantly established downstream or within close proximity of urban centres, cultivated areas, mining developments as well as WWTWs. WWTWs are of great concern for the whole northern region as most sampling stations recorded tolerable to unacceptable standards of most or all selected water quality parameters especially in terms of *Faecal coliform*. Most of the WWTWs facilities within these WMAs do not comply with set standards and can be attributed to these facilities being mismanaged, inadequate or in need of proper maintenance. This needs to be addressed to avoid future significant environmental human health problems and risks.

9.1 Limpopo WMA

9.1.1 WMA Overview

The Limpopo WMA comprises of the Crocodile West and Marico, Limpopo as well as the Luvuvhu catchment areas and is predominantly characterised by low rainfall and significant inter-dependencies for water resources between catchments and neighbouring WMAs. The major rivers within the Limpopo catchment are the Matlabas, Mokolo, Lephalala, Mogalakwena, Sand, Nzhelele and Nwanedi. Few sites are available for the construction of major dams mainly due to the flatness of the WMAs terrain as well as the aridity. Surface water potential has also largely been

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developed. Groundwater is used extensively due to relatively favourable formations and is overexploited in certain areas. Several inter-water management area transfers exist which brings additional water into the WMA (Fig. 9.1).

The WMA is mainly centred around game, livestock and irrigation farming with increasing mining developments. A transfer from the Crocodile West catchment to the Mokolo catchment is planned to support the increase in mining and power generation in the Lephalale area.

The Luvuvhu River sub-catchment is located in the north-east region of the WMA, and is the only well-watered catchment in the WMA with the Mutale River being its main tributary. Thohoyandou is the main urban area with large rural populations scattered across the area. Groundwater is utilised on a large scale by all water use sectors. The Limpopo catchment includes the Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele rivers which together with smaller tributaries flow northwards towards the Limpopo River. The catchment varies from being highly developed urban areas such as Polokwane (50% of urban population), Lephalale and Mokopane to rural communities relying on subsistence farming. The catchment is also characterised by irrigation areas as well as mining in the form of large coal and platinum mining operations located close to Lephalale.

The Crocodile West and Marico catchment, located in the south-east, supports major economic activities and an urban population of approximately 5 million. It is consequently the second most populated catchment in the country with the largest proportional contribution to the country's national economy. The catchment is highly

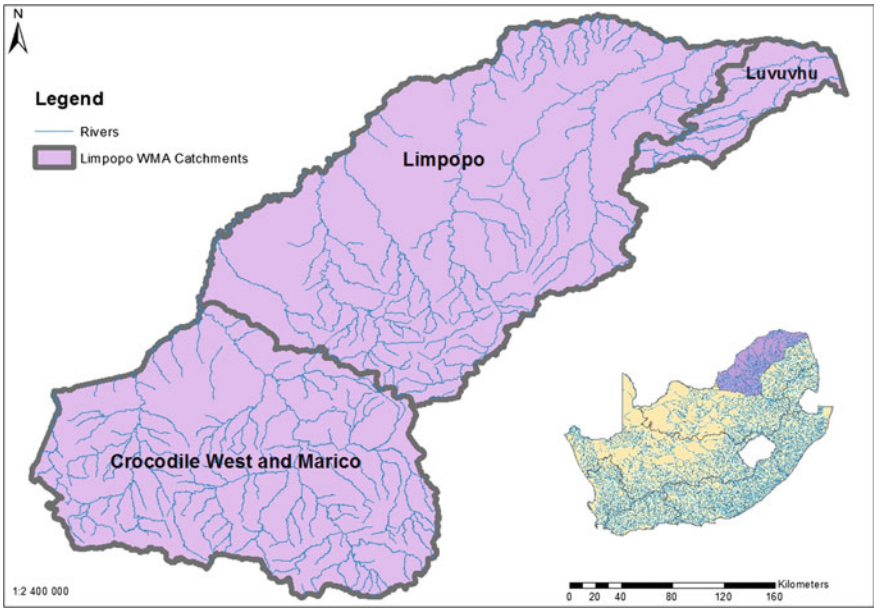

Fig. 9.1 The main catchments of the Limpopo WMA

altered by catchment development (dominated by urban areas and industrial complexes), extensive irrigation along major rivers with game and livestock farming occurring in other parts.

The development and utilisation of surface water occurring naturally have reached its full potential in the WMA. Increasing quantities of effluent return flow from urban and industrial areas offer considerable potential for reuse, but the effluent is at the same time a major cause of pollution in some rivers. Population and economic growth centred on the Johannesburg–Pretoria metropolitan complex as well as mining developments are expected to continue strongly as well.

Water quality monitoring of surface water resources are limited, with large parts of the WMA not having any monitoring data available especially in the central and north-eastern parts of the Limpopo catchment (Fig. 9.2). A total of 264 sampling stations had suitable data for the time period and were evaluated. Of these 264 sampling stations, 195 are river-, 37 are dams/barrages-, 11 are spring/eyes- and 21 wastewater treatment works (WWTWs) sampling points. River and dam/barrage sampling points are distributed across the WMA while spring/eyes are located mostly on the outskirts of the WMA. WWTWs are predominantly located closer to urban built-up areas and in some cases mining developments.

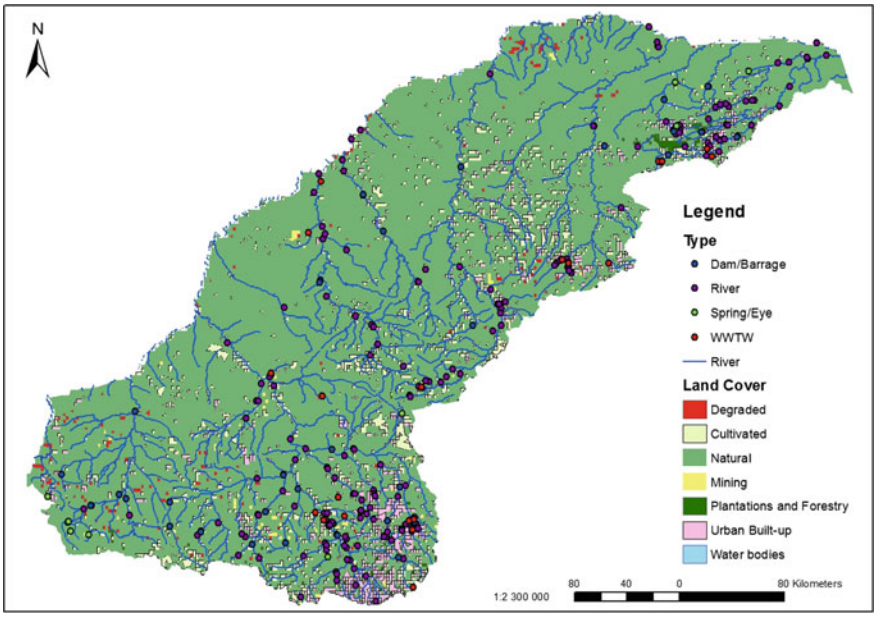

Fig. 9.2 Water quality sampling sites used and land cover of the Limpopo WMA

9.1.2 Risk Areas for Domestic Use

The Limpopo WMA is mostly dominated by no- and low-risk areas especially in the less developed regions of the WMA. A total of 189 (71.5%) of sampling stations were found to be of no risk and 53 (20%) of sampling stations low-risk areas (Fig. 9.3).

Most of the significant risk areas (Risk level 2 and 3) are in close proximity to urban built-up areas and in some cases cultivated areas and mining developments. Medium-risk areas include six river sampling points and seven WWTWs located in the Crocodile West and Marico catchment, located in the south-east of the WMA, and two WWTWs sample points in the Limpopo sub-catchment. These medium risk areas are predominantly located closely downstream from urban built-up, cultivated and mining land cover areas. High-risk areas were recorded at 6 river- and one WWTW sampling points, all located in the Crocodile West and Marico catchment. These sampling stations had tolerable to unacceptable levels of all or most of the selected physical and chemical water quality parameters and are of major concern. These areas are once again located directly downstream from urban built-up, cultivated and mining developments. Water at these locations can therefore not be directly used for domestic use.

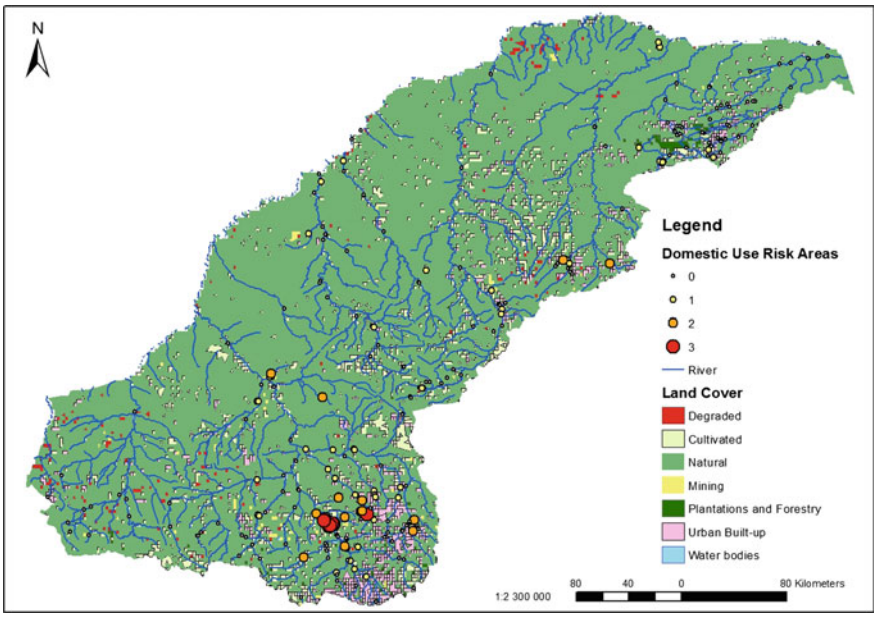

Fig. 9.3 Overall risk profile and significant risk areas for the Limpopo WMA (domestic use standards)

9.1.3 Risk Areas for Aquatic Ecosystems

In terms of aquatic ecosystem water quality standards, no sampling stations qualified as having no risk. All sampling stations varied from low, medium to high risk. The WMA is dominated by low risk, however, 9% of sampling stations are of medium risk and 15% high (Fig. 9.4). Therefore, in terms of aquatic health, the WMA is predominantly degraded at varying degrees.

Most of the significant risk areas (Risk level 2 and 3) are in close proximity to urban built-up areas as well as cultivated areas and mining developments. Medium risk areas include river, dam/barrage and WWTWs sampling points located across the WMA. These medium risk areas are predominantly located closely downstream from urban built-up, cultivated and mining land cover areas. High-risk areas were recorded predominantly in the Crocodile West and Marico catchment in terms of rivers and WWTWs. These sampling stations had tolerable to unacceptable levels of all or most of the selected physical and chemical water quality parameters and are of major concern for current and future aquatic health. Of great concern is that most WWTWs are of medium to high risk which indicates that these facilities greatly contribute to the overall degradation of the WMA. Rivers which are of medium to high risk are predominantly located downstream of these WWTWs as well as in some cases downstream of urban built-up or mining developments.

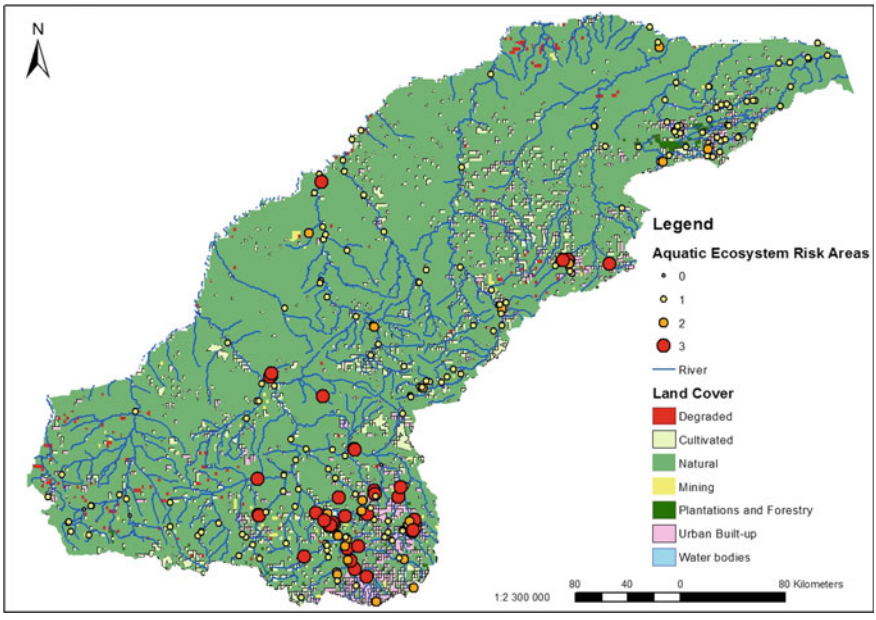

Fig. 9.4 Overall risk profile and significant risk areas for the Limpopo WMA (aquatic ecosystem standards)

9.1.4 Risk Areas for Irrigation

Irrigation water quality is predominantly of very low risk as 66% of sampling stations' measured water quality is of no risk and 26% are characterised as low risk. A total of 15 sampling stations were found to be of medium risk and 6 high risks (Fig. 9.5). Significant risk areas are once again located downstream of urban built-up areas or WWTWs. Sampling points which measured predominantly tolerable to unacceptable water quality and categorised as medium risk included 10 rivers located predominantly in the Crocodile West and Marico catchment. Five of the other medium risk sampling stations are located downstream of WWTWs, four of these are located in the Crocodile West and Marico catchment.

High-risk areas have been identified to be 5 river sampling stations and one WWTW located in the Crocodile West and Marico catchment. These river high-risk areas are once again predominantly located downstream of mining developments, WWTW or urban built-up areas. Farmers in the catchment, therefore, have to use caution when using water close to these points for irrigation purposes as it may have unintended negative effects on the growing of crops.

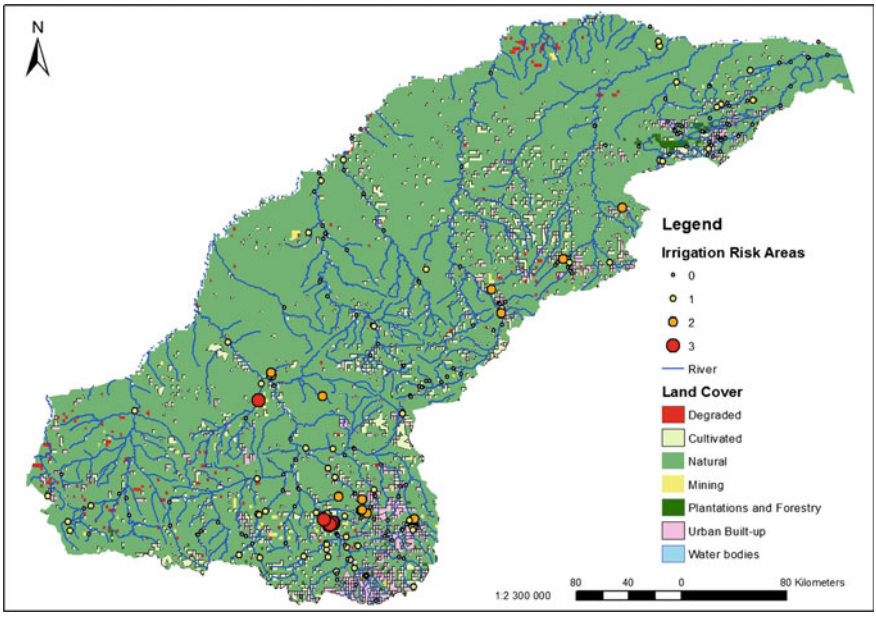

Fig. 9.5 Overall risk profile and significant risk areas for the Limpopo WMA (irrigation standards)

9.1.5 Risk Areas for Industrial Use

Water quality standards for industrial use is predominantly low to no risk as 42% of sampling stations were of low risk and 32% of no risk. However, a large amount of sampling stations measured tolerable to unacceptable industrial use water quality as a total of 49 sampling stations were found to be of medium risk (18%) and 17 sampling stations of high risk (8%) (Fig. 9.6). This may become a major concern in future with the continued increase in industrial and mining developments as tolerable to unacceptable water quality may negatively influence these sectors through affecting the efficiency of production processes and increasing financial costs.

Significant risk areas are spread across the WMA but are mostly located downstream of urban built-up areas, mining developments or WWTWs. Sampling points which measured predominantly tolerable to unacceptable water quality and categorised as medium risk located in the Crocodile West and Marico catchment included 21 rivers, 6 dams/barrages, 2 springs/eyes and 6 WWTWs. Medium-risk areas located in the Limpopo and Luvuvhu catchment areas comprised of 10 rivers, 1 spring/eye and 3 WWTWs.

High-risk areas have been identified to be 13 river-, 1 dam- and 3 WWTWs sampling stations located predominantly once again in the Crocodile West and Marico catchment. These high-risk areas are located within close proximity or directly downstream of mining developments, WWTWs or urban built-up areas. Industries, espe-

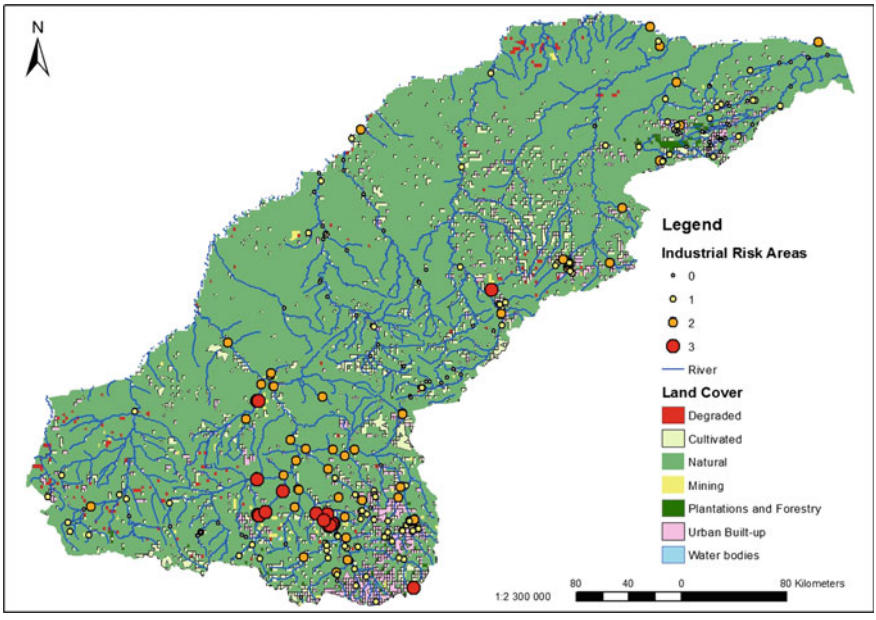

Fig. 9.6 Overall risk profile and significant risk areas for the Limpopo WMA (industrial standards)

cially in the Crocodile West and Marico catchment, therefore might have to use increased caution in future when directly using water from these points for industrial processes as it may have negative effects on production processes or cause unintended financial losses.

9.1.6 Chlorophyll a *and* Faecal Coliform *Risk Areas*

A total of only 36 sampling stations recorded *Chlorophyll a* concentrations during the time period. *Chlorophyll a* water quality standard for domestic use is predominantly of high to medium risk as 61% is of an unacceptable standard and 39% of sampling stations measured tolerable concentrations (Fig. 9.7). A large amount of sampling stations measured unacceptable to tolerable recreational water quality as a total of 22 sampling stations were found to have measured unacceptable levels (61%) and seven sampling stations measured tolerable levels (19%) (Fig. 9.8).

The Crocodile West and Marico catchment is once again the most degraded in terms of *Chlorophyll a* concentrations and high and medium risk areas are located close or directly downstream of urban built-up areas, agricultural areas as well as industrial activities.

Most sampling stations which measured *Chlorophyll a* during the time period, therefore, recorded unacceptable to tolerable concentrations. High concentrations

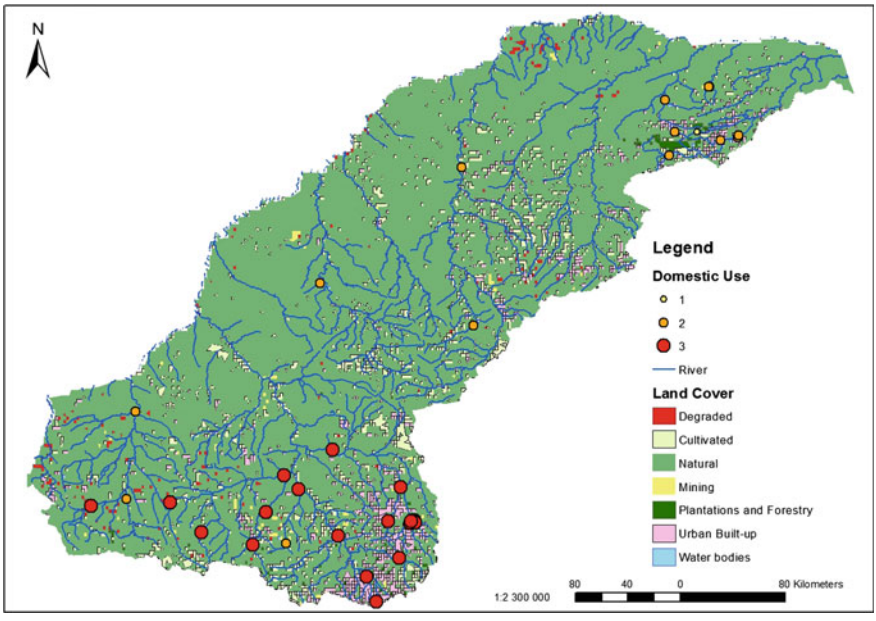

Fig. 9.7 Overall risk profile of *Chlorophyll a* for the Limpopo WMA (domestic use standards)

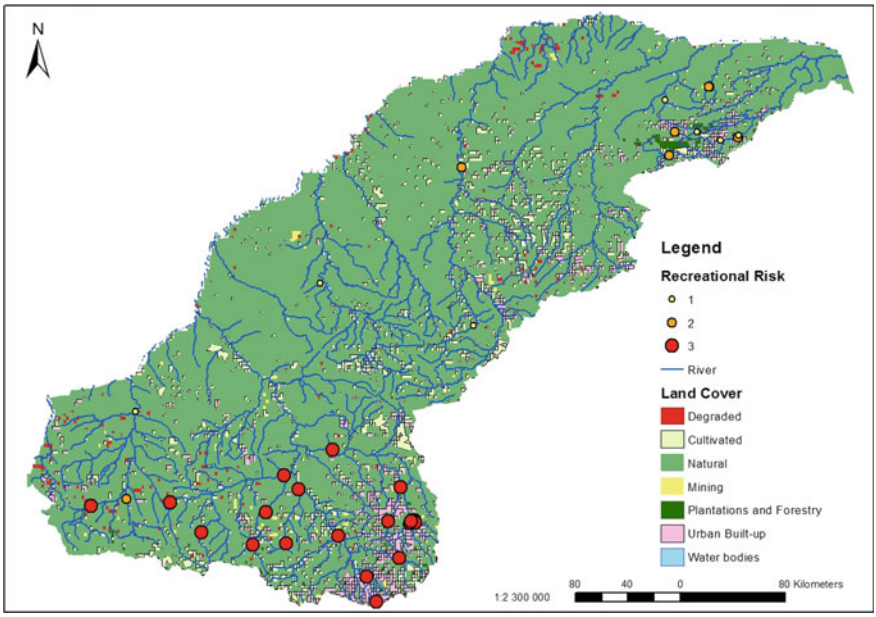

Fig. 9.8 Overall risk profile of *Chlorophyll a* for the Limpopo WMA (recreational use standards)

are due to tolerable to unacceptable levels of ammonia, nitrate as well as phosphate in these sampling areas mainly due to human activities. This should be of major concern as continued degradation will negatively influence all water use sectors through becoming unusable for domestic use, unsafe for recreational activities, further degrades aquatic ecosystems and negatively affects the efficiency of production processes and increasing financial costs for industrial activities ultimately affecting the water-food-energy nexus.

In terms of *Faecal coliform*, a total of 129 sampling stations measured its concentration within the WMA. Only three sampling stations measured acceptable standards and three sampling stations measured tolerable standards for domestic use. The other 123 sampling stations all measured unacceptable standards for domestic use and are spread across the WMA (Fig. 9.9).

In terms of irrigation use standards, 6 sampling stations measured acceptable standards, 40 tolerable standards and 83 unacceptable standards (Fig. 9.10). The predominant *Faecal coliform* risk profile for the WMA in terms of irrigation use is therefore high to medium and should be of concern for both domestic, recreational as well as irrigation use. The main contributor for the unacceptable standards of *Faecal coliform* can be attributed to poor or incompetent WWTW facilities as most of these facilities have been identified as problem areas in this WMA. Other contributors may include cultivated areas in the form of runoff of animal waste as well as from urban built-up or rural areas which may not have competent wastewater treatment facilities.

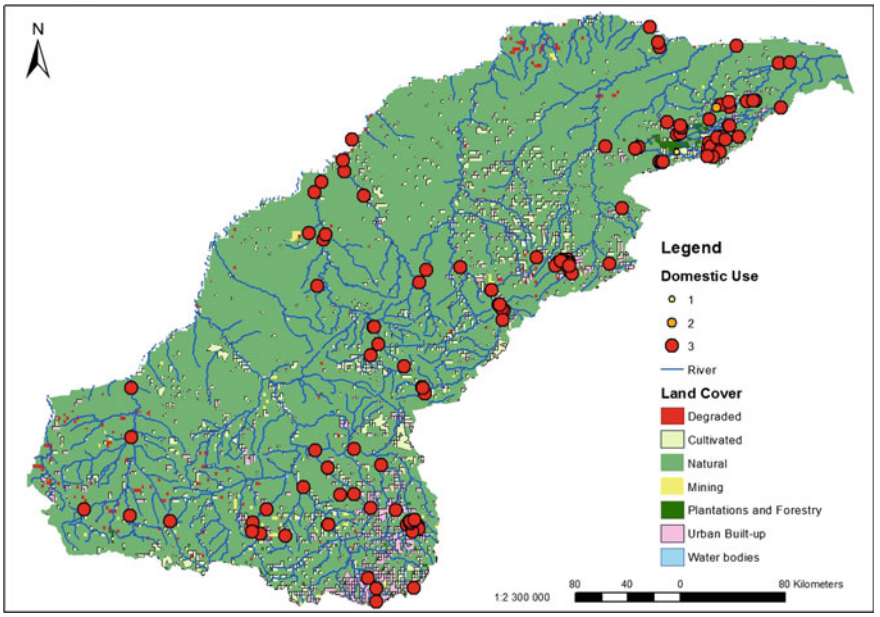

Fig. 9.9 Overall risk profile of *Faecal coliform* for the Limpopo WMA (domestic use standards)

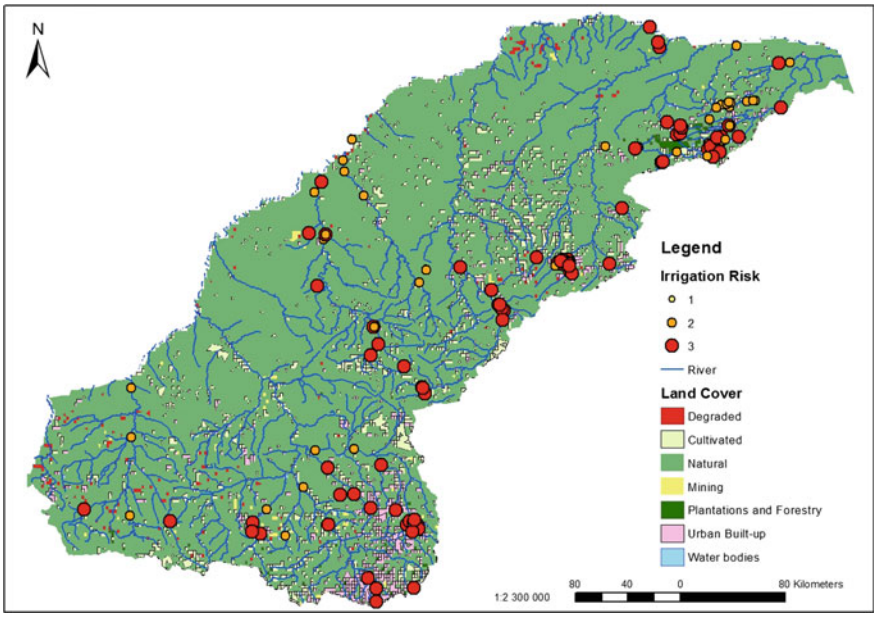

Fig. 9.10 Overall risk profile of *Faecal coliform* for the Limpopo WMA (irrigation standards)

Even though the WMA is largely underdeveloped the water resources of the WMA are heavily impacted in terms of salinity as well by urbanisation, wastewater discharges and platinum mining activities.

The Upper Marico River is in relatively good condition in terms of water quality. The agricultural return flow is a major factor and has caused the lower Marico falls to be of tolerable standard due to salinity issues. The areas which are monitored in the Limpopo and Luvuvhu catchments are of acceptable to ideal range of salinity but some areas are of unacceptable standard especially the upper Sand River catchment. The Crocodile West and Marico catchment should be of focus as most of the high and medium-risk areas are located here. The region needs to investigate the current state of their WWTWs as most of these do not comply with most or all water quality standards.

It should also be highlighted that a substantial portion of the water used in the catchment is transferred from the Vaal River and further afield and currently contributes to the good buffering capacity of the WMA. A decrease in additional water capacity could consequently lead to areas of acceptable water quality becoming tolerable to unacceptable due to the decrease in buffering capacity and affect all water uses in the WMA in terms of availability and quality.

9.2 Olifants WMA

9.2.1 WMA Overview

The Olifants WMA is made up of the Olifants, Letaba as well as Shingwedzi River catchments. The Shingwedzi River includes the Mphongolo, Phugwane, Shisha and Mashakwe Rivers and falls largely within the Kruger National Park. Land use outside the park area is predominantly subsistence farming and informal urban settlements. There are several small gold mines which have been developed in the south-western part of the catchment, however, these mines have very limited impact on the local economy and have recently been closed down.

The Letaba catchment, located in the northern region of the WMA, has two main tributaries namely the Klein and Groot Letaba Rivers (Fig. 9.11). The Groot Letaba River catchment includes main urban areas of Tzaneen and Nkowakowa whereas the Klein Letaba River catchment contains the town of Giyani. Rural populations are scattered throughout this catchment. The catchment is highly regulated by several dams in the upper and middle reaches of the river and is further regulated by irrigation weirs which limit flows into the Kruger National Park. The upper parts of the Klein Letaba River as well as along the Groot Letaba River are characterised by intense irrigation farming where vegetables and, citrus and a variety of fruits are grown. The already limited existing water resources have been overexploited to try and meet the growing demand for irrigation, afforestation, industries as well as domestic water demands.

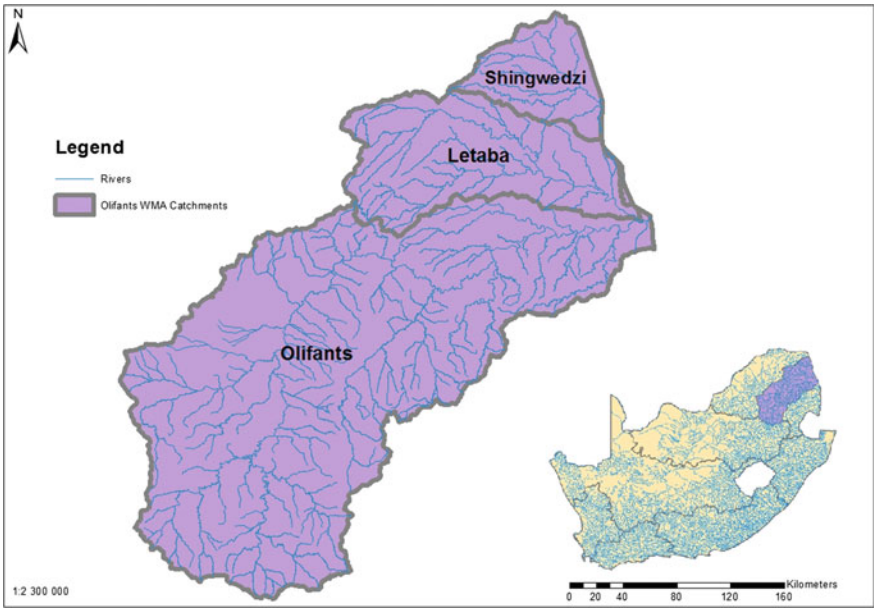

Fig. 9.11 Main catchments of the Olifants WMA

The Olifants catchment system is the major part of the WMA and its main tributaries include the Wilge, Elands and Ga-Selati Rivers on the west and the Klein-Olifants, Steelpoort, Blyde, Klaserie and Timbavati Rivers on the east. This catchment is highly utilised and regulated and its water resources are increasingly under pressure due to continued accelerated development and scarcity of water resources. Mining is the main economic activity within this catchment and extensive irrigation occurs. Most of the central and north-western areas of the catchment are characterised by underdevelopment and scattered rural villages with migrant workers. Rain-fed cultivation (grain and cotton) is dominant in the southern and north-western parts of the catchment. Most of the catchment, however, remains under natural vegetation for livestock and game farming as well as conservation. Severe overgrazing is, therefore, a major threat in many areas (Fig. 9.12).

The water quality monitoring of surface water resources is spread across the WMA but is highly concentrated in the south or Olifants catchment due to this catchment being highly developed in terms of mining, urban built-up and cultivation. A total of 278 sampling stations were evaluated (22 dams/barrages, 233 rivers and 23 WWTWs) distributed across the WMA.

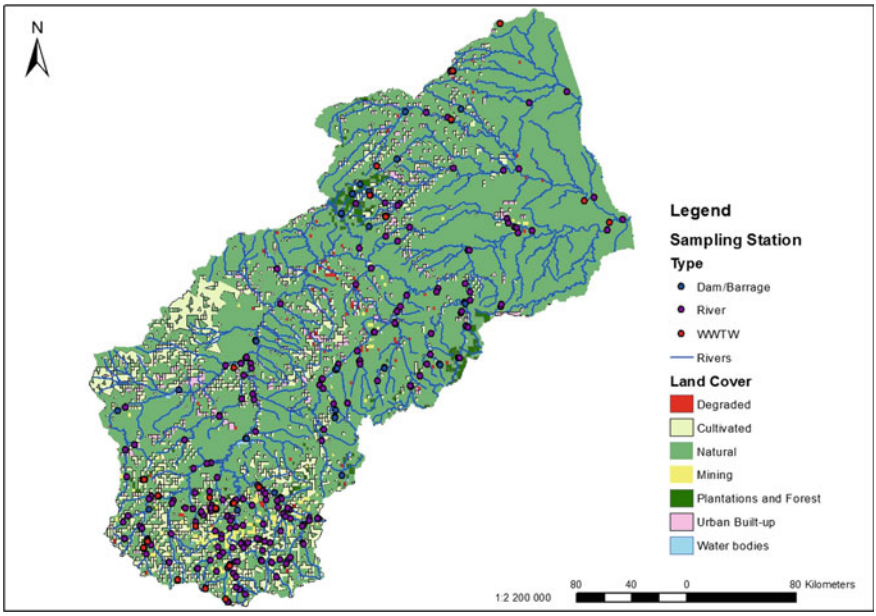

Fig. 9.12 Water quality sampling stations used and land cover of the Olifants WMA

9.2.2 Risk Areas for Domestic Use

The Olifants WMA is predominantly of no to low risk in terms of domestic use water quality standards especially in the central and north-eastern regions of the WMA. Of the 278 sampling stations, 180 (65%) of sampling stations fell in the no risk category and 68 (24%) were categorised as low risk (Fig. 9.13).

Significant risk areas (Risk level 2 and 3) are predominantly found in the Olifants catchment which is dominated by mining developments and urban built-up areas. High-risk areas are found in the Letaba catchment of the WMA, located downstream of WWTWs. A total of 28 medium risk areas (1%) were identified which are predominantly located in rivers and WWTWs located in the southern region of the WMA. Only 2 high-risk areas were identified which are both WWTWs type sampling stations. These 2 areas should, therefore, be highlighted as they are also located close to urban built-up areas, i.e. human populations which use the water for domestic purposes. Most of the risk areas are located within close proximity or directly downstream from mining developments (especially in the Olifants catchment), urban built-up or settlements as well as WWTWs.

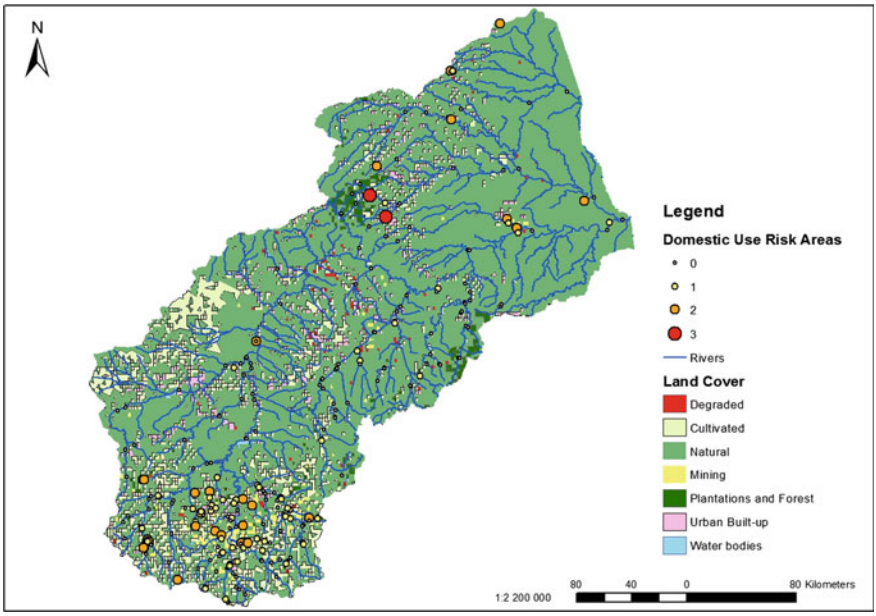

Fig. 9.13 Overall risk profile and significant risk areas for the Olifants WMA (domestic use standards)

9.2.3 Risk Areas for Aquatic Ecosystems

In terms of aquatic ecosystem water quality, the WMA is predominantly of low to medium risk in the less developed regions (Fig. 9.14). A total of 17 sampling stations were established to be of no risk and 199 (72%) of sampling stations were classified as low risk. Significant risk areas were once again predominantly located in developed regions especially in the Olifants catchment. A total of 41 medium risk areas and 21 high-risk areas were identified. These risk areas are mainly located close or downstream of mining developments or urban built-up. High-risk areas are mainly located downstream of WWTWs. Unacceptable concentrations of chloride, nitrate, ammonia and phosphate were recorded.

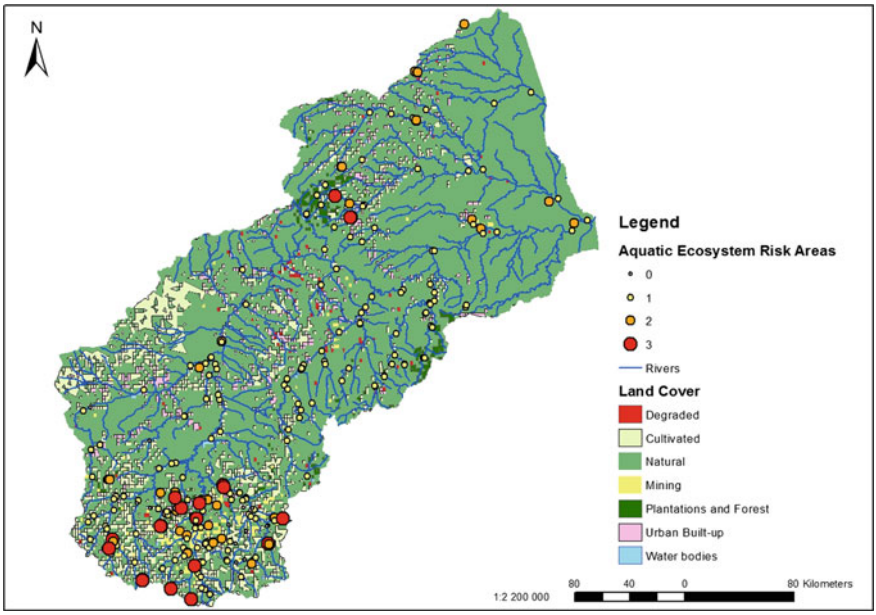

Fig. 9.14 Overall risk profile and significant risk areas for the Olifants WMA (aquatic ecosystem standards)

9.2.4 Risk Areas for Irrigation Use

Irrigation risk areas almost correspond with domestic use risk areas. The WMA is dominated by no- (189 sampling stations) and low (66 sampling stations) risk areas which mainly occur within the central and north-eastern regions of the WMA (Fig. 9.15). Low-risk areas are mostly located further downstream from cultivated land, mining developments as well as rural settlements.

Medium and high-risk areas were once again established downstream or in close proximity of mining developments, urban built-up as well as WWTWs. High-risk areas are WWTWs located in the north of the WMA close to scattered built-up areas. The Olifants catchment holds most of the risk for the WMA due to most of the medium risk areas falling in it. The high concentration of mining developments as well as urban built-up areas and WWTWs are the biggest contributors to pollution in this catchment. Other catchments also have medium to high-risk areas but to a much lesser extent. This is due to less development and main contributors are rural settlements and cultivation practices. Farmers which are located close to or downstream of mines, as well as urban built-up and WWTWs, therefore need to reserve caution as irrigation water quality risks have been identified.

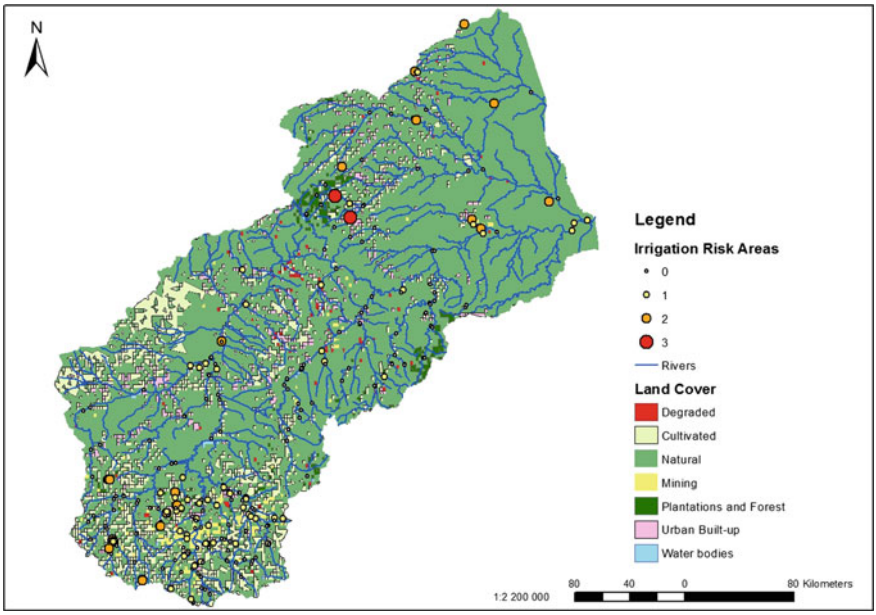

Fig. 9.15 Overall risk profile and significant risk areas for the Olifants WMA (irrigation standards)

9.2.5 Risk Areas for Industrial Use

The Olifants WMA is predominantly characterised by low-risk areas in terms of industrial use water quality (Fig. 9.16). A total of 67% sample stations were classified as low risk, followed by 16% no risk (located mainly in undeveloped areas), 14% medium risk and 3% high risk.

Medium risk areas are spread across the WMA. These areas are mostly located in close proximity of mining activities, urban built-up or rural settlements as well as downstream of WWTWs. The 10 sampling stations which were identified as high-risk areas are 2 WWTWs located in the Letaba catchment (north) and 8 river sampling points all located in the Olifants catchment. These sampling stations had tolerable to unacceptable levels of all or most of the selected physical and chemical water quality parameters and are of major concern.

Industrial activities which are located close to these areas and which make use of this water should take note as the use of poor water quality can negatively influence production processes and lead to unintended financial costs due to ineffective production processes.

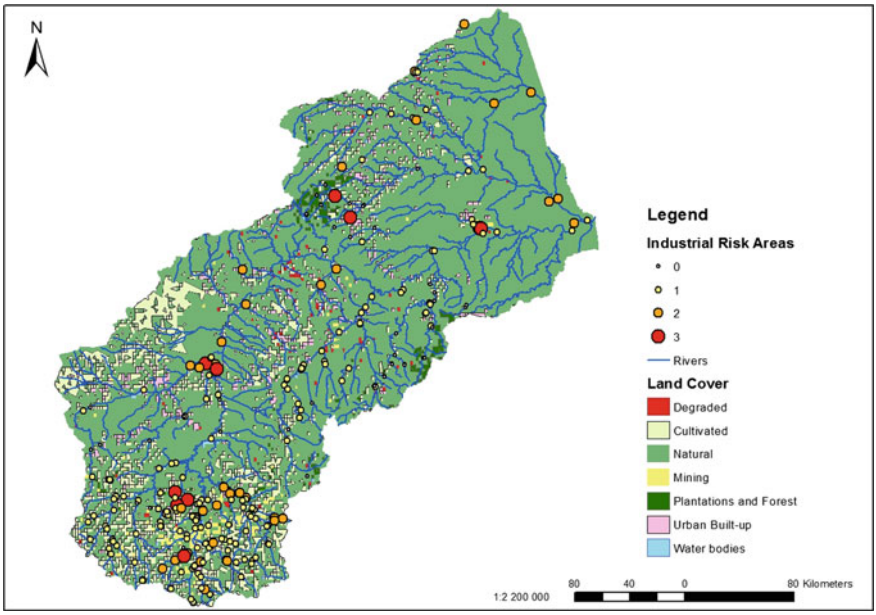

Fig. 9.16 Overall risk profile and significant risk areas for the Olifants WMA (industrial use standards)

9.2.6 Risk Areas for Chlorophyll a *and* Faecal Coliform

Only 31 sampling stations measured *Chlorophyll a* within the Olifants WMA. The *Chlorophyll a* concentrations in terms of domestic use are mainly of a medium risk as 84% of sampling stations were of tolerable standard (Fig. 9.17). Only 1 station measured acceptable domestic standards in the WMA and is in an underdeveloped area of the Olifants catchment.

In terms of recreational risk, the Olifants WMA is predominantly of a low risk as 61% of sampling stations measured acceptable standards for *Chlorophyll a* (Fig. 9.18). High-risk areas are however present. High-risk areas which measured unacceptable standards of *Chlorophyll a* can be found downstream or within close proximity of mining developments, urban built-up as well as WWTWs.

The risk profile of *Chlorophyll a* might change if more monitoring sampling stations are included especially in the Olifants catchment which is highly developed and degraded. A total of 126 sampling stations measured *Faecal coliform* levels within the WMA. The *Faecal coliform* levels for domestic use is overall of unacceptable standard as 97% of stations measured unacceptable levels. Only 2 stations measured acceptable levels and another 2 stations tolerable concentrations (Fig. 9.19).

In terms irrigation standards the WMA is of a high to medium risk as 71% of sampling stations measured unacceptable standards and 28% tolerable standards (Fig. 9.20). The Olifants WMA is therefore predominantly of high risk for water use

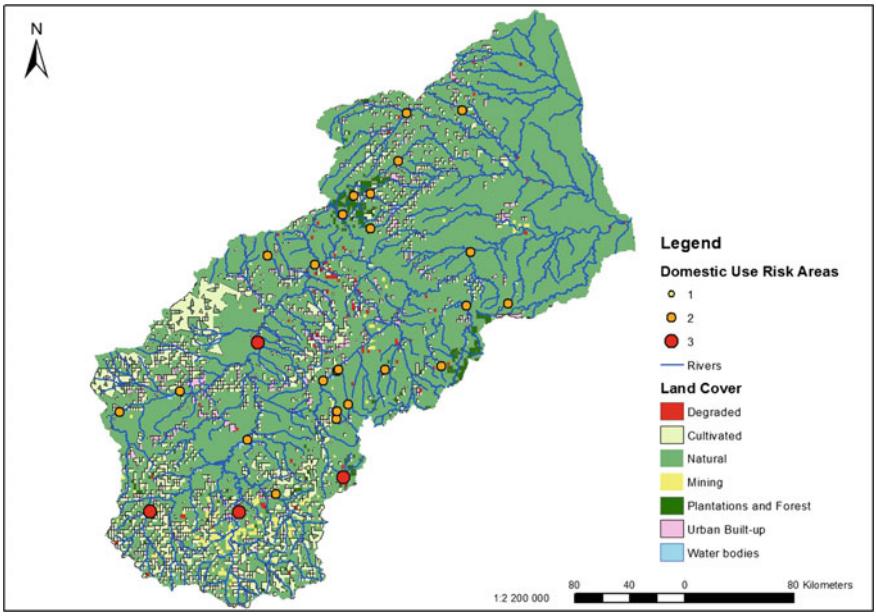

Fig. 9.17 Overall risk profile of *Chlorophyll a* for the Olifants WMA (domestic use standards)

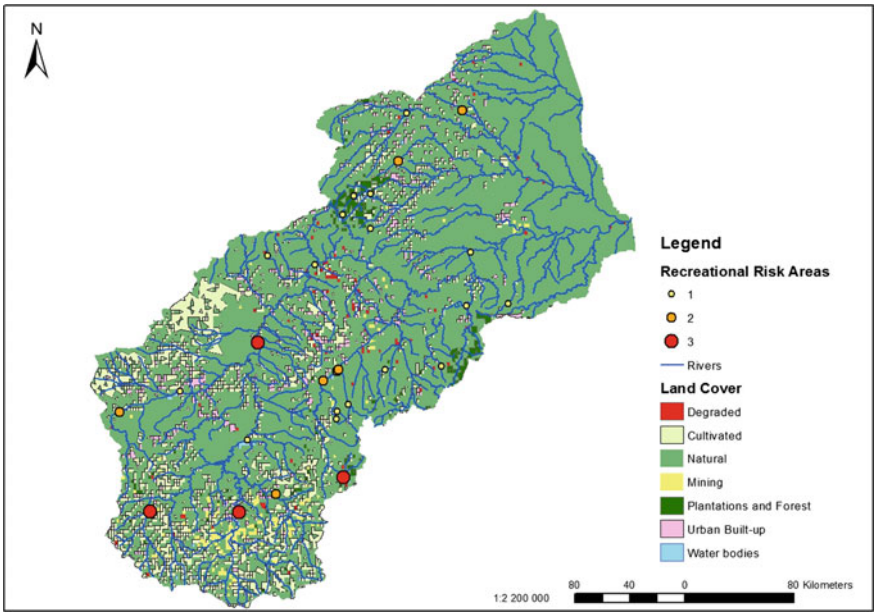

Fig. 9.18 Overall risk profile of *Chlorophyll a* for the Olifants WMA (recreational use standards)

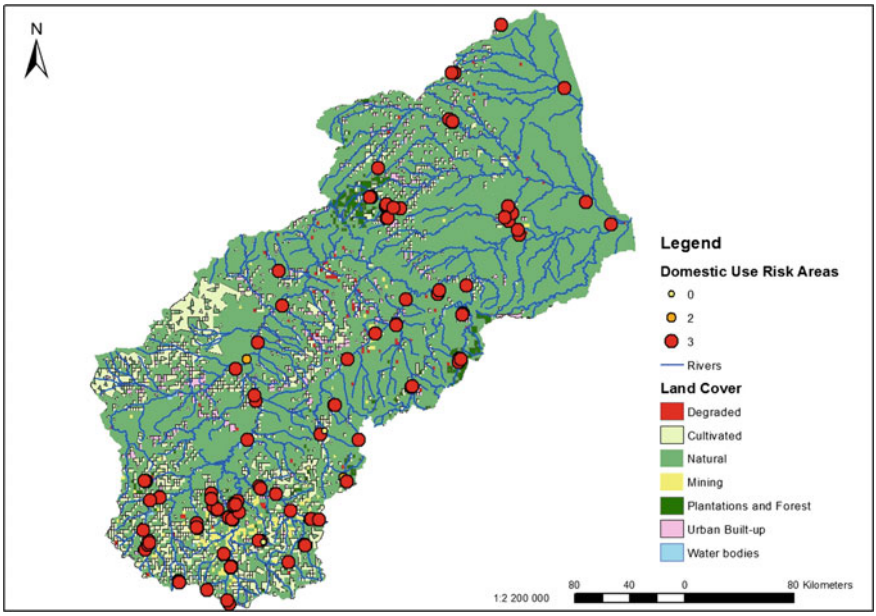

Fig. 9.19 Overall risk profile of *Faecal coliform* for the Olifants WMA (domestic use standards)

in terms of *Faecal coliform* levels. Tolerable to unacceptable levels of can mainly be attributed to runoff of animal wastes from cultivated areas as well as poor or inadequate WWTWs for urban built-up areas.

The Olifants WMA is, therefore, overall highly stressed and stress on its water resources will be exacerbated by continued population growth and development. The further development of its water resources is very limited and future developments will be forced to rely on local sources of water. Salinity is a major factor within this WMA as water sources especially within the Olifants catchment are mostly of unacceptable to tolerable standard. The Lower Olifants in the Kruger National Park is however of an acceptable standard as well as tributaries within the upper reaches of the catchment. The lower reaches of catchments are predominantly of unacceptable water standards and are largely due to mining, irrigation return flows as well as wastewater discharges. Smaller tributaries fall within the ideal range for most physical and chemical water quality parameters.

Water quality monitoring could be improved upon in the Letaba catchment (northern region) as it is currently limited. Monitoring of *Chlorophyll a* concentrations as well as *Faecal coliform* levels need to be improved upon as it is currently very limited and these parameters have been identified as being mostly of unacceptable to tolerable standards.

The ecological condition of the Olifants WMA falls in the moderately modified state to largely modified state. The upper reaches of the Olifants and within the Letaba and Shingwedzi catchments are predominantly natural to largely natural and

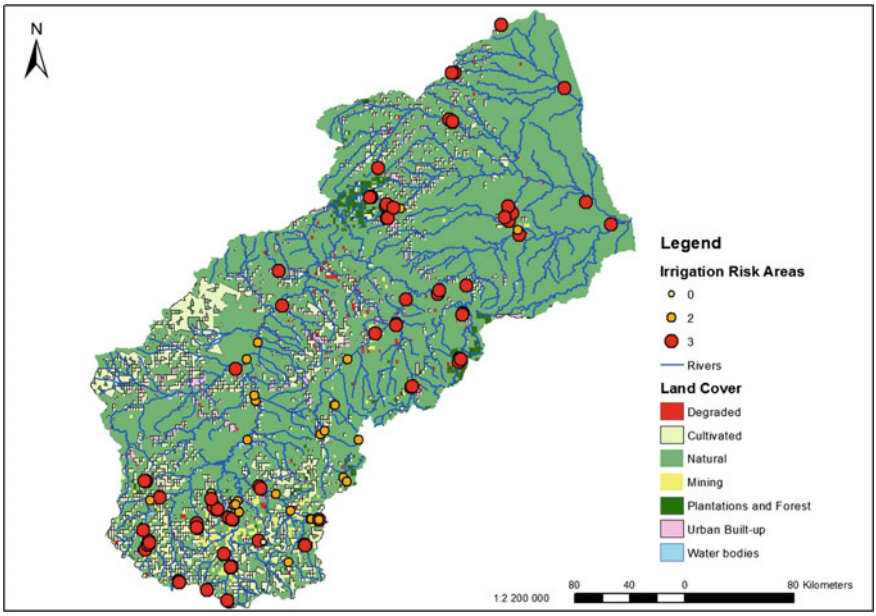

Fig. 9.20 Overall risk profile of *Faecal coliform* for the Olifants WMA (irrigation standards)

are less impacted as the majority of these rivers fall within the Kruger National Park. Mining and agricultural activities, as well as urban developments, are the biggest contributors to the modification of the WMA.

A precautionary approach to management is therefore required to try and maintain good conditions of some tributaries and attempt to minimise the further degradation of already severely stressed water resources. There are still surface water resources which have the capacity to accept degrees of impact, however, the development of these need to receive caution as their development can have unintended cumulative effects.

9.3 Inkomati-Usuthu WMA

9.3.1 Overview of WMA

The Inkomati-Usuthu WMA, located in the north-eastern part of the country, borders Mozambique and Swaziland and the Kruger National Park occupies 35% of the WMA. All of its rivers flows through Mozambique into the Indian Ocean and includes the Sabi-Sand River system, the Crocodile River East system, the Komati and Lomati system as well as the Usuthu River system (Fig. 9.21).

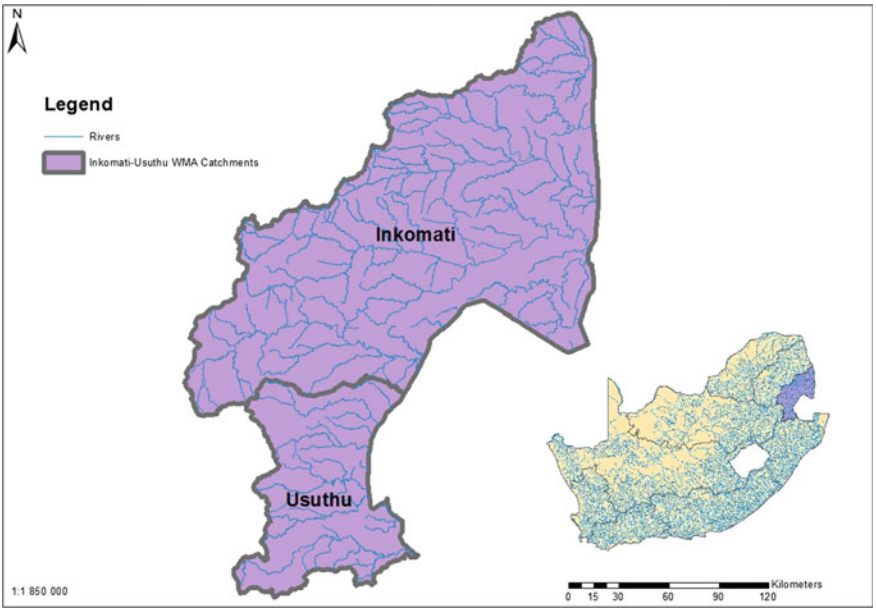

Fig. 9.21 Main catchments of the Inkomati-Usuthu WMA

Economic activities within the WMA are predominantly focussed on irrigation and afforestation with related industries and commerce. Due to the Kruger National Park, there is also a very strong ecotourism industry. Coal mining activities are, however, emerging in the upper reaches. The Kruger National Park remains the key feature of the WMA with the Sabi River flowing through it making it one of the most important ecological rivers in South Africa. Important urban centres in the WMA include Mbombela, White River, Komatipoort, Carolina, Badplaas, Barberton, Sabie, Bushbuckridge, Kanyamazan, Matsulu, Lothair, Piet Retief and Amsterdam. Dams have been constructed on all of the WMAs main rivers and tributaries, making the WMA well regulated. Water resources of rivers are consequently fully utilised or in balance and future water supply will require reconciliation options.

Joint management by South Africa and Swaziland exists in part of the water resources of the Komati Basin Water Authority. The Inkomati River is subject to international cooperative agreement with Mozambique which obligates South Africa to have a minimum of 2 m^3/s supplied to Mozambique. Swaziland is also dependent on the Usuthu River and relies on responsible upstream use from South Africa.

Groundwater utilisation is also relatively small due to the well-watered nature of the WMA. Most of the present yield from the Komati River, west of Swaziland, is transferred to the Olifants WMA for power generation.

Large areas of the WMA have been developed under irrigation and crops include fodder, grain, tobacco, citrus, tropical fruits and sugar. Commercial forestry is also present in the high rainfall escarpment and mountain areas of the WMA. Land outside

of the Kruger National Park remains predominantly under natural vegetation for livestock and game farming as well as for conservation.

Overgrazing is rampant especially in some of the densely populated rural areas. Areas which have good soils and favourable topography make use of dryland cultivation. Mbombela, previously known as Nelspruit, is the biggest urban centre and scattered rural villages with high population densities are widespread in the WMA.

The upper parts of the Sabi River catchment are densely commercially afforested and the land use in the middle reaches is a combination of sub-tropical fruits and dense informal settlements. The lower reaches of the river falls within the Kruger National Park. The upper region of the Usuthu River catchment is sparsely populated and land use is dominated once again by afforestation with limited irrigation (Fig. 9.22).

Water quality monitoring of surface water resources is spread across most of the WMA except in the north-eastern part of the WMA where the Kruger National Park is located (Fig. 9.22). A total of 234 sampling stations had suitable data for the time period. The types of sampling stations include 21 dam/barrages, 185 rivers, 4 springs/eyes and 24 WWTWs spread across the whole WMA.

The current main stressors in the WMA are the high water demands by Eskom, irrigation, afforestation as well as industry and rapidly increasing domestic water demands. Mining is also a factor in the WMA. Major mining activities occur within the Inkomati catchment in the Baberton and Mbombela areas as well as in the Crocodile River catchment close to the Kaap River. Minerals include gold, asbestos, iron, nickel, copper and manganese and a significant number of coal reserves. Gold

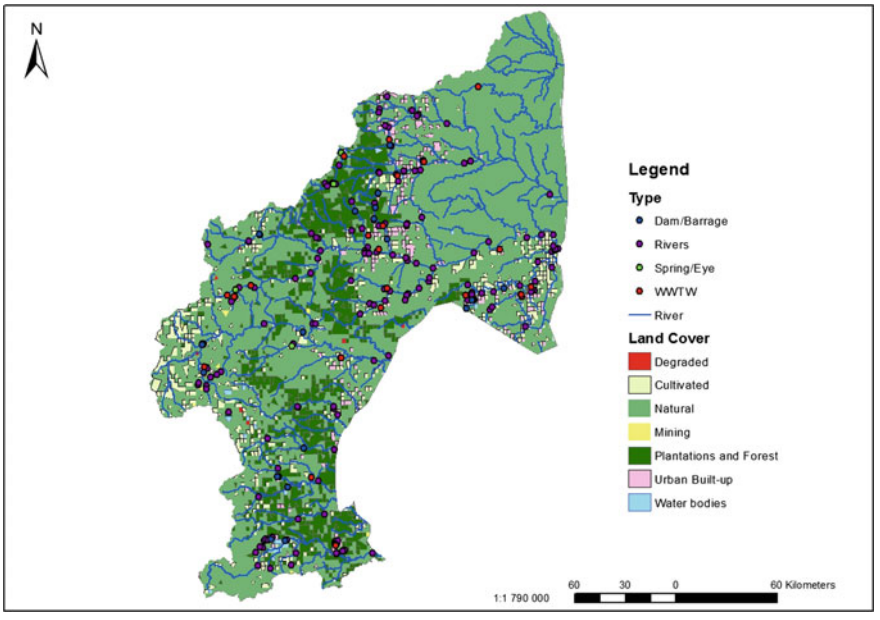

Fig. 9.22 Water quality sampling sites used and land cover of the Inkomati-Usuthu WMA

and other mineral mining operations are widespread but have been reduced to small-scale operations. Coal mining occurs extensively in the south-west region of the WMA which is mainly used for fuel for large thermal power stations in the neighbouring Olifants WMA.

9.3.2 Risk Areas for Domestic Use

Inkomati-Usuthu WMA is of no to low risk in terms of domestic use water quality standards for physical and chemical water quality parameters. A total of 193 (82%) sampling stations were identified to be of no risk and 26 (11%) sampling stations of low risk (Fig. 9.23).

Fifteen sampling stations were recorded to be of medium risk. Three of these medium risk areas are rivers located within the Inkomati catchment primarily downstream of urban built-up areas as well as cultivated areas. Three of the WWTWs located in the Inkomati catchment have also been identified to be of medium risk. Seven river sampling points and 2 WWTWs within the Usuthu catchment were also classified as being of medium risk. The medium-risk rivers are once again located within close proximity or downstream of urban built-up as well as cultivated areas.

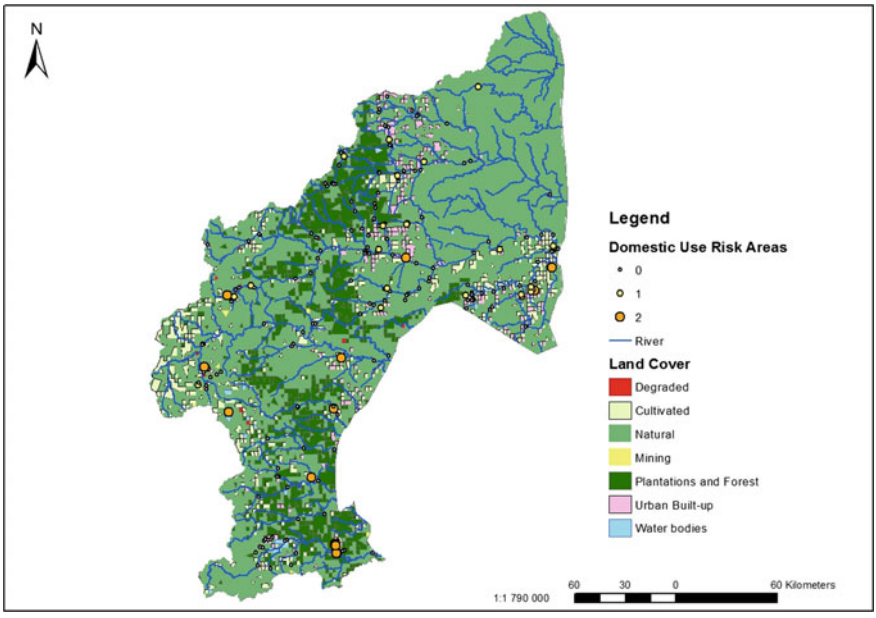

Fig. 9.23 Overall risk profile and significant risk areas for the Inkomati-Usuthu WMA (domestic use standards)

Mining operations located close to Baberton (western region of the catchment) also play a role as some medium-risk areas have also been identified.

Overall the WMA is of no to low risk in terms of domestic use water quality guidelines, however, this may change if precaution is not taken in future developments such as expansion of mining in the WMA.

9.3.3 Risk Areas for Aquatic Ecosystems

The WMA is mostly dominated by low-risk areas in terms of aquatic ecosystem water quality standards. A total of 167 (71%) sampling stations are classified as low-risk areas, followed by 36 (15%) of sample stations no risk, 20 (9%) medium risk and 11 (5%) high-risk areas (Fig. 9.24). Medium-risk areas are spread across the WMA, however, most occur within close proximity or directly downstream of urban built-up or cultivated areas. Five medium-risk areas are located at rivers and 6 downstream of WWTWs within the Inkomati catchment. The other medium-risk areas are 6 rivers and 3 of the 4 WWTWs located in the Usuthu catchment.

In terms of high-risk areas, 2 rivers in the Inkomati catchment and nine WWTWs fell in this risk category. These high-risk areas are located close to urban centres, rural settlements, cultivated areas as well as mining developments. Most of the sam-

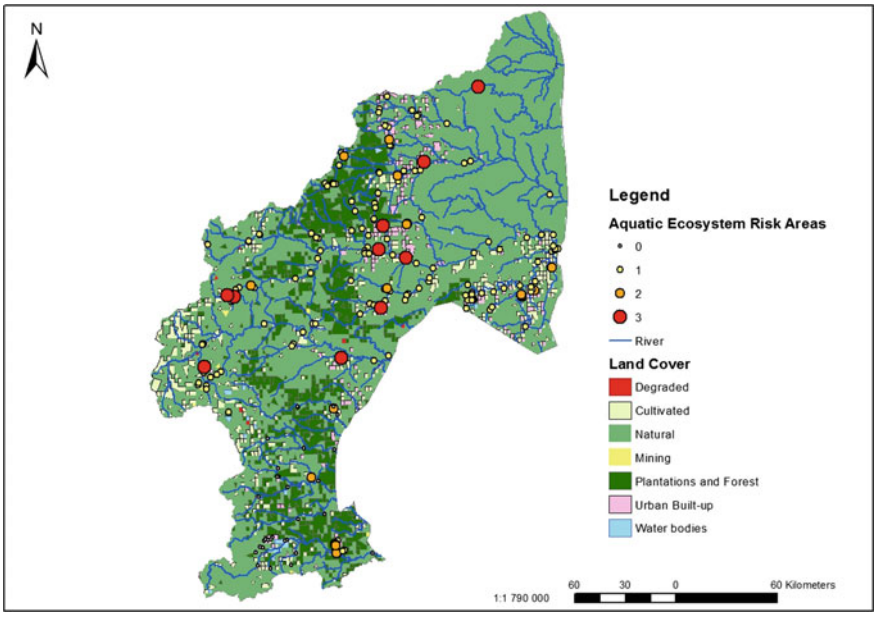

Fig. 9.24 Overall risk profile and significant risk areas for the Inkomati-Usuthu WMA (aquatic ecosystem standards)

pling stations measured tolerable to unacceptable standards of EC, chloride, sodium, ammonia, phosphate and nitrate.

9.3.4 Risk Areas for Irrigation Use

The WMA is characterised by mostly acceptable irrigation water quality standards. Most sample stations were categorised as being of no to low-risk areas. A total of 198 (85%) are of no risk and 23 (10%) of low risk (Fig. 9.25). Only 13 sampling stations were classified as being of medium risk. These medium risk sample points are predominantly rivers and 2 WWTWs located in the Usuthu catchment. The tolerable concentrations can be attributed to cultivated areas as well as urban built-up. Tolerable concentrations were mostly recorded for ammonia, nitrate and phosphate water quality parameters which can be connected to fertiliser use and pollution from WWTWs. The overall water quality risk profile for irrigation use in the WMA is however no to low risk.

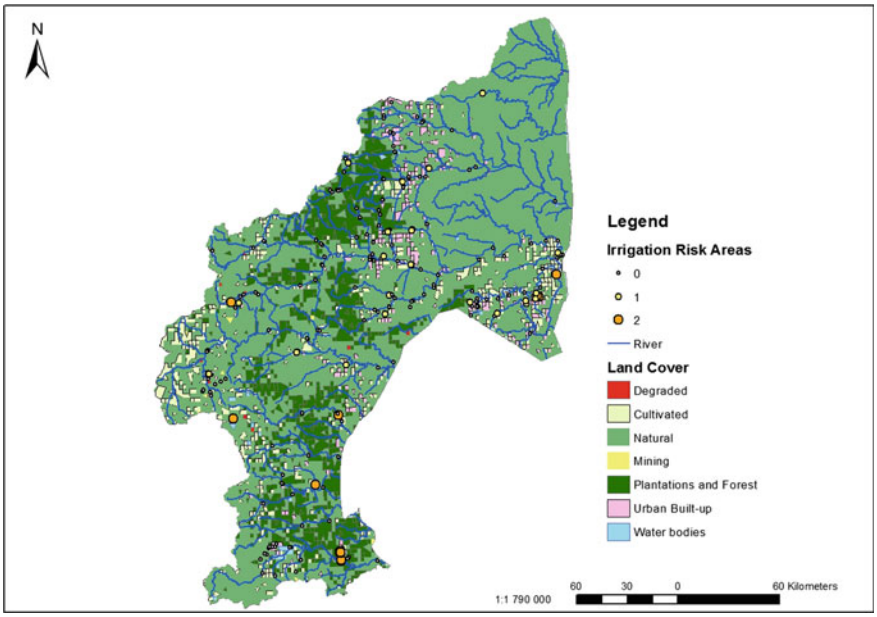

Fig. 9.25 Overall risk profile and significant risk areas for the Inkomati-Usuthu WMA (irrigation standards)

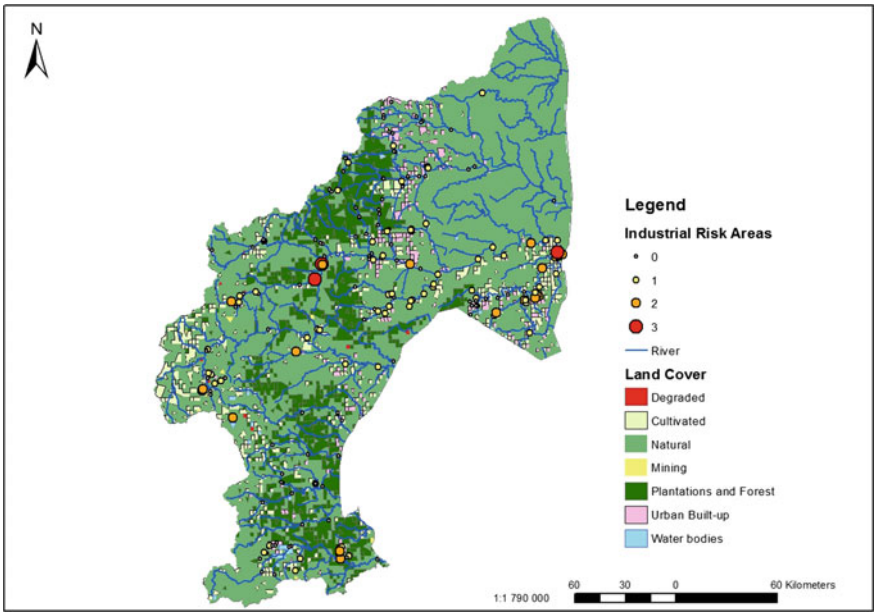

Fig. 9.26 Overall risk profile for the Inkomati-Usuthu WMA (industrial standards)

9.3.5 Risk Areas for Industrial Use

The overall water quality risk profile for the WMA in terms of industrial use ranges between no to low risk. The WMA therefore has mostly acceptable industrial water quality standards with 139 (59%) sample stations being of no risk and 70 (30%) sample stations categorised as low risk (Fig. 9.26).

Significant risk areas were established for the WMA. A total of 22 medium risk and 3 high-risk areas were identified in the WMA. Medium-risk areas are spread across the WMA. Most of the medium risk areas are rivers located in the Inkomati catchment close to urban built-up areas as well as cultivated areas. In terms of the 3 identified high-risk areas, all 3 are rivers located in the Inkomati catchment predominantly downstream of urban built-up areas.

9.3.6 Risk Areas for Chlorophyll a *and* Faecal Coliform

Concerningly, only 9 sampling stations measured and recorded *Chlorophyll a* concentrations within the WMA. There is therefore a major lack of *Chlorophyll a* monitoring within the WMA. All 9 of the sampling stations measured tolerable concentrations

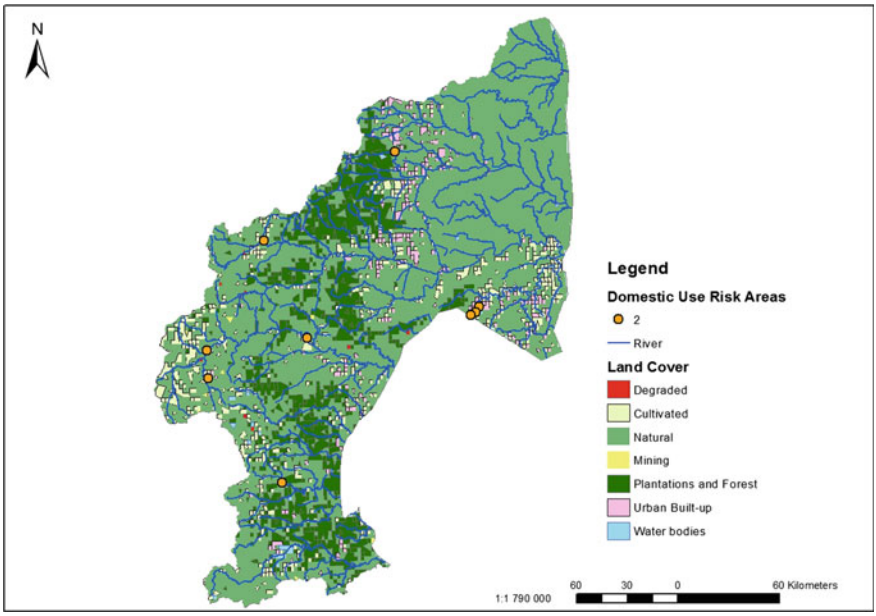

Fig. 9.27 Overall risk profile of *Chlorophyll a* for the Limpopo WMA (domestic use standards)

for domestic use and are located within close proximity or directly downstream of urban built-up or rural settlements (Fig. 9.27).

The WMA is overall of low risk in terms of recreational water quality standards as all sampling stations measured acceptable *Chlorophyll a* concentrations. No concrete conclusions can, however, be made due to the lack of available sampling stations in the WMA.

A total of 194 sampling stations measured *Faecal coliform* levels in the WMA for the time period and are scattered over the whole WMA. Monitoring is, however, lacking in the central region of the WMA. The WMA is overall of a high risk in terms of domestic use water quality standards as 181 (93%) sampling stations measured unacceptable *Faecal coliform* levels (Fig. 9.28).

The overall unacceptable levels for domestic use of *Faecal coliform* across the WMA can be attributed to animal wastes from cultivated areas but also poor or inadequate WWTWs. The scattered nature of rural settlements is also a challenge regarding the treatment of wastewater and contributes to further degradation in the form of sewage pollution.

The overall risk profile in terms of irrigation use is medium to high as 69% of sampling points measured tolerable levels of *Faecal coliform* (Fig. 9.29). High-risk areas are scattered across the catchment but are predominantly located either within close proximity or downstream of WWTWs, urban built-up, cultivated areas or rural settlements. The WMA needs to invest in the upgrading or development of WWTWs especially in terms of rural settlements.

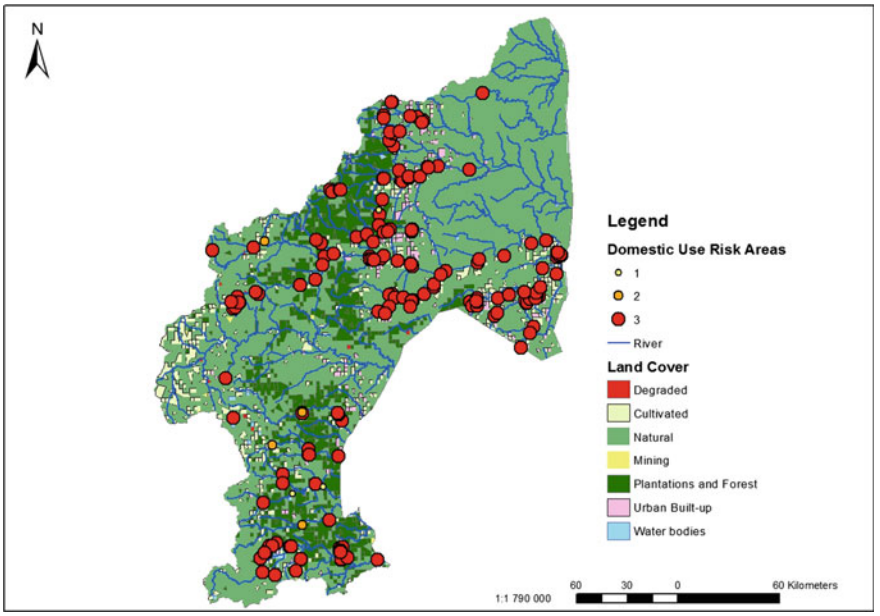

Fig. 9.28 Overall risk profile of *Faecal coliform* for the Limpopo WMA (domestic use standards)

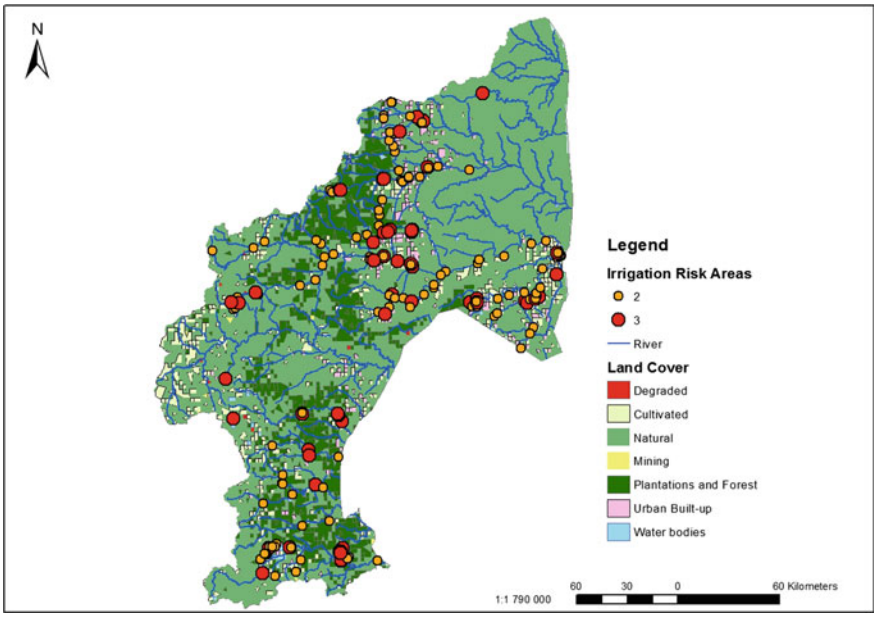

Fig. 9.29 Overall risk profile of *Faecal coliform* for the Limpopo WMA (irrigation use standards)

The overall ecological condition of the WMA is therefore mostly good to fair as most of the system is in a natural to largely natural state or moderately modified state. The lower reaches of the Crocodile River are however largely modified due to developments and is largely affected by acid rock drainage from old gold mining areas. Other smaller tributaries such as the Upper Sabie River and lower reaches of the Komati River out of Swaziland are also largely modified.

The water quality of the Inkomati-Usuthu catchment is therefore of a low risk in terms of physical and chemical water quality parameters. The salinity of the Crocodile river is tolerable with lower reaches falling in the unacceptable range. Some areas have, however, been identified as medium to high risk and should be taken note of especially those located downstream of WWTWs. The WMA clearly has an issue regarding *Faecal coliform* which should be addressed through upgrading or establishing WWTWs. The WMA should also invest in the expansion of sampling points for *Chlorophyll a* as currently monitoring is lacking.

In terms of water stress, 24% of the WMA is characterised by stressed surface water resources which are under threat and 3% of surface water resources which need a precautionary approach in management. Major current and future threats within the WMA therefore include future population growth, expansion of urban built-up areas and rural settlements as well as proposed mining developments.

9.4 Conclusions

The northern WMAs vary significantly according to the established risk areas. The Limpopo WMA is characterised by low rainfall and significant inter-dependencies for water resources between catchments and neighbouring WMAs. Significant risks were identified for most of the evaluated water quality standards in terms of the selected physical and chemical water quality parameters. The WMA is predominantly of low to no risk for most of the selected water quality parameters in terms of physical and chemical water quality parameters. However, significant risk areas were established and most of these were found to occur in the Crocodile West and Marico catchment which is also the second most populated catchment and largest proportional contribution to the country's national economy. These identified significant risk directly correlate with the highly altered nature of the catchment. Significant risk areas, especially those located in the Crocodile West and Marico catchment need to be addressed as this catchment is the second most populated in the country and plays a significant role in the country's economy. The further degradation of its water resources could pose increasing risks to different water use sectors in terms of quality but also availability as water may become unusable for certain uses.

The Olifants WMA is largely characterised by scattered rural populations, intense irrigation farming in the northern parts of the WMA and extensive mining, irrigation and urban areas in the south. Most of the catchment remains under natural vegetation for livestock and game farming as well as conservation. Severe overgrazing is a major threat in many areas and contributes to environmental degradation in the WMA

together with extensive mining operations and other activities in urban built-up areas. The WMA is predominantly of low to no risk for most of the selected water quality parameters in terms of physical and chemical water quality parameters. The WMA is of medium risk for *Chlorophyll a* concentrations in terms of domestic use, however, the WMA has a low amount of sampling stations which recorded *Chlorophyll a*. The overall risk profile for *Chlorophyll a* might change (be of higher risk) if more monitoring stations are included. *Faecal coliform* levels were predominantly of an unacceptable standard and should be addressed by evaluating current WWTWs in terms of capacity, overall condition as well as management thereof.

The Inkomati-Usuthu WMA is predominantly focused upon irrigation and afforestation with related industries and commerce with coal mining emerging in the upper reaches. Current main stressors in the WMA are the high water demands by Eskom, irrigation, afforestation as well as industry and rapidly increasing domestic water demands. The WMA is predominantly of low to no risk for most of the selected water quality parameters in terms of physical and chemical water quality parameters. The WMA had only nine sampling stations which recorded *Chlorophyll a* and no concrete conclusion can be made due to lack of data. Mostly unacceptable levels of *Faecal coliform* were recorded for the whole WMA.

All of the northern WMAs need to expand their water quality monitoring network especially in terms of the measurement of *Chlorophyll a*, as eutrophication is an identified major water quality problem in the country, and *Faecal coliform*. All three of the WMAs also need to place a significant focus on the improvement of their WWTWs are these facilities are not functioning up to standard. These significant risk areas need to be addressed to minimise or limit future environmental degradation, significant human health risks as well as socio-economic costs.