**General Integrated Science Unit 3**

**Task 3: How changes to abiotic factors affect the carrying capacity of ecosystems**

**Assessment Type : Extended Response**

**Weighting : 15%**

**Time allowed for the task:**

* 1 week to research the topic and complete your ***notes*** at home/class 50% Marks /22
* 1 hour lesson to answer questions related to your research in class 50% Marks /22

**Dryland and Irrigation Salinity:**

Salinity refers to the salt content of water or soil at a level where the salt content damages soil and degrades water quality. Excessive salt in soil and water places many native plant species and aquatic animals at risk of extinction. In addition, salinity causes economic loss through loss of productive agricultural land and damage to roads and buildings and puts the supply of acceptable drinking water at risk.

Your task is to research the economic, social and environmental impacts of salinity and what measures Australia is taking to ensure the sustainability of its ecosystems.

**Elements of the task:**

**Part A. Create a set of research notes on the following questions.**

* Why is Australia’s landscape so salty?
* How does “Dryland Salinity” occur – use diagrams to illustrate your answer?
* How does “Irrigation Salinity” occur?
* How does increasing soil salt levels impact the survival of organisms and the carrying capacity of an ecosystem?
* Why is salinity a major environmental problem in Australia?
* How could the increasing salinity of Australian soil impact on agriculture?
* What social problems will result if the salinity of the soil continues to increase in Australia?
* What is Australia doing to reverse the changes it has brought about to the environment and help increase the sustainability of its ecosystems?

<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1370.0~2010~Chapter~Salinity%20%286.2.4.4%29>

<https://www.qld.gov.au/environment/land/soil/salinity/impacts>

<http://www.abc.net.au/science/slab/salinity/>

<http://www.abc.net.au/science/slab/salinity/>

<http://www.abc.net.au/science/slab/trees/story.htm>

<http://www.epa.sa.gov.au/soe_2008/resources/education/dry_land_salinity.pdf>

<http://austhrutime.com/lake_eyre.htm>

<http://www.water.wa.gov.au/water-topics/water-quality/managing-water-quality/understanding-salinity>

<https://www.dpaw.wa.gov.au/images/conservation-management/salinity/salinity-strategy.pdf>

**Part B. Research notes**

* These will be handed in prior to the assessment and will be marked on organisation, understanding of the concepts covered and coverage of the topic.

**Part C. In-class assessment will comprise of:**

* specific questions based on the research notes you have made.

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| **Requirements for assessment** | **Due dates** |
| * Research notes | **Thursday 12th April** |
| * In-class assessment | **Thursday 12th April** |

**Validation Questions – Salinity**

1. Where does all the salt in Australia’s landscape come from originally? (2 marks)

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1. Describe two ways that salt is brought closer to the surface resulting in death of plants and ecosystems.

(4 marks)

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1. Using the knowledge gained from your research, make two environmental or social predictions about what could happen to the agricultural industry here in Western Australia if the salinity of the soil continues to rise. Include the reasons for your predictions. (4 marks)

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1. How do you think the increase in salinity levels will impact on the economy of Western Australia?

(2 marks)

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1. The increasing salinity levels in the top soil are having a huge environmental impact on Australia’s landscapes, waterways and cities. Discuss one environmental impact that salt is having on the waterways and one environmental impact on a land based ecosystem. (4 marks)

Waterway - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. The economic, social and environmental impacts of increasing salinity of Australian soils are having a detrimental effect on Australia as a whole. Discuss three methods/actions that Australia is trying to implement to reverse the damage that salinity is doing to the ecosystems. (6 marks)

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**Validation Questions – Salinity Mark Scheme**

**Research Notes – see information on each aspect of the research for clarification**

**Part A. Create a set of research notes on the following questions. (22 marks)**

* Why is Australia’s landscape so salty?

2 reasons minimum = 2 marks

* How does “Dryland Salinity” occur – use diagrams to illustrate your answer?

Diagram 1 mark, explanation 1 mark

* How does “Irrigation Salinity” occur?

Two ways it can occur minimum = 2 marks

* How do increasing soil salt levels impact the survival of organisms and the carrying capacity of an ecosystem?

Two effects on organisms mentioned (2 marks), and two effects on the carrying capacity mentioned (2 marks)

* Why is salinity a major environmental problem in Australia?

2 reasons minimum (2 marks)

* How could the increasing salinity of Australian soil impact on agriculture?

2 reasons (2 marks)

* What social problems will result if the salinity of the soil continues to increase in Australia?

2 linked social problems identified (2 marks)

* What is Australia doing to reverse the changes it has brought about to the environment and help increase the sustainability of its ecosystems?

Three of the following: total 6 marks

Comment about what Australia is doing/going to do (1 mark), and how that will help the sustainability of the ecosystem (1 mark)

**22 marks for validation**

1. Where does all the salt in Australia’s landscape come from originally? (2 marks)

***Weathering of rocks, evaporated from ocean water carried in rain clouds, left behind when land pushed up from the sea long ago, deposited during interglacial periods – 2 logical answers***

1. Describe two ways that salt is brought closer to the surface resulting in death of plants and ecosystems.

(4 marks)

***Dryland salinity (1) – remove trees, so water table rises dissolving the salt as it rises (1)***

***Irrigation salinity(1) – watering excessively of crops rises the water table as only small rooted crops, crops use water and level salt behind increasing the levels of salt in the soil = dehydration of crops (1)***

1. Using the knowledge gained from your research, make two predictions about what could happen to the agricultural industry here in Western Australia if the salinity of the soil continues to rise. Include the reasons for your predictions. (4 marks)

***Crop yield will drop so farms not productive enough to make money(1) – more of farm covered in salt so less crop can grow(1)***

***Crops poison and die – farmers lose all the money(1), soil too salty plants dehydrate die (1)***

***Land unusable so farmers have to leave land as cannot sell (1), salt makes land unproductive (1)***

***Economy of area go down as little money coming into the community(1), farms closing, little returns from crops (1)***

***Unwanted plants thrive (1), crops in competition so yield reduced (1)***

1. How do you think the increase in salinity levels will impact on the economy of Western Australia?

(2 marks)

***The economy will go down (1), loss of crops, loss of money coming in people cannot afford goods so whole community suffers (1)*** *some reasoning as to why will drop*

1. The increasing salinity levels in the top soil are having a huge environmental impact on Australia’s waterways and landscapes. Discuss one environmental impact that salt is having on the waterways and one environmental impact on a land based ecosystem. (4 marks)

**eg**

***Waterway – salt washes into steams changing ecosystem (1), plants and animals die as can’t cope with salt, water undrinkable, fishing industry, animals that eat the fish die,*** *one follow on point*

***Land based – salt destroys road/buildings = cost to economy, ground water not drinkable – community has to more/desalination plants cast money, installing drainage in subsurface***

*2 x a point and a link/explanation*

1. The economic, social and environmental impacts of increasing salinity of Australian soils are having a detrimental effect on Australia as a whole. Discuss three methods/actions that Australia is trying to implement to reverse the damage that salinity is doing to the ecosystems. (6 marks)

Eg 3 methods stated (3) and reason why /what will they achieve (3)

***Construction of drainage channels to prevent irrigation salinity, maintaining current native vegetation so problem doesn’t expand, revegetation to reduce the water table away from salt levels, plant salt tolerant plants in saline areas to try and reduce water and salt levels so in future salt will reduce enough for normal replanting, protect wetland to prevent erosion and salt runoff, water monitoring of crops to ensure only enough used***

**RESEARCH NOTES**

* Why is Australia’s landscape so salty?

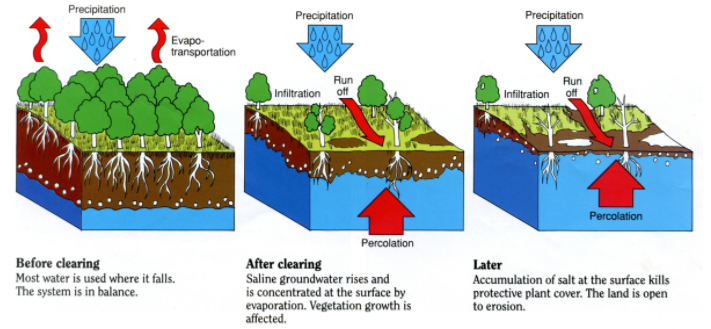
There is salt everywhere in Australia; vast amounts of it, mostly located underground. It has built up over many thousands of years, originating from the weathering of rock minerals or the simple act of sea salt dropping via rain or wind.

Salt in our water resources is generally derived from three sources. Firstly, small amounts of salt (primarily sodium chloride) are evaporated from ocean water and are carried in rainclouds and deposited across the landscape with rainfall.

Secondly, some landscapes may also contain salt that have been released from rocks during weathering (gradual breakdown), and thirdly, salt may remain in sediments left behind by retreating seas after periods where ocean levels were much higher or the land surface much lower.

Salt concentrations in rainfall are higher near the coast, and decrease as one moves inland. Depending on rainfall and other factors, between about 3 and 360 kg of salt per hectare are deposited each year across Western Australia

* How does “Dryland Salinity” occur – use diagrams to illustrate your answer?

[Salinity in drylands](https://en.wikipedia.org/wiki/Dryland_salinity) can occur when the water table is between two and three metres from the surface of the soil. The salts from the groundwater are raised by capillary action to the surface of the soil. This occurs when groundwater is saline (which is true in many areas), and is favoured by land use practices allowing more rainwater to enter the aquifer than it could accommodate. For example, the clearing of trees for agriculture is a major reason for dryland salinity in some areas, since deep rooting of trees has been replaced by shallow rooting of annual crops.

* How does “Irrigation Salinity” occur?
* Salinity from [irrigation](https://en.wikipedia.org/wiki/Irrigation) can occur over time wherever irrigation occurs, since almost all water (even natural rainfall) contains some dissolved salts.[[2]](https://en.wikipedia.org/wiki/Soil_salinity#cite_note-2) When the plants use the water, the salts are left behind in the soil and eventually begin to accumulate. Since soil salinity makes it more difficult for plants to absorb soil moisture, these salts must be leached out of the plant root zone by applying additional water. This water in excess of plant needs is called the [leaching fraction](https://en.wikipedia.org/wiki/Leaching_model). Salination from irrigation water is also greatly increased by poor [drainage](https://en.wikipedia.org/wiki/Drainage) and [use of saline water](https://en.wikipedia.org/wiki/Biosalinity) for irrigating agricultural crops.
* Salinity in urban areas often results from the combination of irrigation and groundwater processes. Irrigation is also now common in cities (gardens and recreation areas).
* Tertiary salinity occurs when water is reapplied to crops or horticulture over many cycles, either directly or by allowing it to filter into the groundwater before pumping it out for re-application. Each time the water is applied, some of it will evaporate and the salts in the water remaining will become more concentrated; very high salt concentrations can result from multiple cycles of reuse.
* How does increasing soil salt levels impact the survival of organisms?
* Water moves into plant roots by a process known as [osmosis](https://www.qld.gov.au/environment/land/soil/soil-testing/soil-terms), which is controlled by the level of salts in the soil water and in the water contained in the plant.
* If the level of salts in the soil water is too high, water may flow from the plant roots back into the soil. This results in dehydration of the plant, causing yield decline or even death of the plant.
* Crop yield losses may occur even though the effects of salinity may not be obvious. The salt tolerance of a specific crop depends on its ability to extract water from salinised soils.
* Salinity affects production in crops, pastures and trees by interfering with nitrogen uptake, reducing growth and stopping plant reproduction.
* Some [ions](https://www.qld.gov.au/environment/land/soil/soil-testing/soil-terms) (particularly chloride) are toxic to plants and as the concentration of these ions increases, the plant is poisoned and dies.
* The most significant off-site impact of dryland salinity is the salinisation of previously fresh rivers. This affects the quality of water for drinking and irrigation—with serious economic, social and environmental consequences for both rural and urban communities.
* High levels of salts may affect the taste of drinking water. Chloride in particular has a low taste threshold. Sodium and magnesium sulfate levels in drinking water may produce a laxative effect and reduce the suitability of a water supply for grazing animals.
* The native Australian vegetation evolved to be salt-tolerant. Many of the woodland species, for example, have deep roots and a high demand for water. Whilst the system was in balance, the salt stayed put. But when European farming arrived and replaced the natives with crop and pasture plants that have shorter roots and need less water, the inevitable happened. With every fall of rain, unused water "leaks" down to the water table, raising it, and bringing the salt up with it. That process continues today, and the volumes of water and salt are vast.
* Why is salinity a major environmental problem in Australia?
* Salinity threatens biodiversity through loss of habitat on land and in water. Areas of remnant and rehabilitated native vegetation are under threat in Western Australia, South Australia, New South Wales and Victoria (NLWRA 2001). In the Western Australian wheat-belt, salinity has caused a 50% decrease in the numbers of wetland bird species, and 450 plant species are threatened with extinction through salinity (ANZECC 2001).
* Although Australian native trees are used to high salt conditions, they cannot survive when salt is brought near the surface by rising water tables.
* Under the soils of the Western Australian wheatbelt and some parts of eastern Australia the salt store is so immense, and the movement of sub-surface water so slow, that restoration to fertility of salt-effected land will take generations. Some areas may never recover. According to the CSIRO, even if we replant up to 80% of the native vegetation, some cleared catchments would not see recovery within normal human timescales.
* The cost of damage to infrastructure is currently $100 million a year. Some 80 country towns across Australia are in trouble. For example, the NSW town of Wagga Wagga needs to annually find $500,000 to deal with the corrosion and degradation of roads, footpaths, parks, sewage pipes and housing by saline seepage. And parts of Western Sydney, in the South Creek catchment, are finding this once rural problem has finally come even to the biggest of cities.
* In Western Australia, the picture is little short of tragic. The CSIRO's [Dr Tom Hatton](http://www.clw.csiro.au/staff/THatton/)points out, with language once reserved for Brazilian rainforests, that the western wheatbelt is losing an area equal to one football oval an hour.
* "Eighty per cent of the remnant native vegetation on farms and fifty per cent on public lands is at risk. The South West of WA is one of the great biodiversity centres on the planet, it is particularly well endowed with plants and animals. Many of those species are restricted naturally to places in the landscape which we will lose to salt. Most of the river beds and banks are degraded, and over half our usable river water is already saline, brackish or marginal.
* Beneath the root zone of the lupins, almost 70 kilograms of nitrogen were lost for each hectare. The nutrient simply drained away, along with 200 millimetres of water. But in the adjacent, undisturbed banksia woodland, there was no loss of either.
* Salt interacts with in-stream biota (animals and plants), changing the ecological health of streams and estuaries. The greatest threat to biodiversity is from the loss of habitat—both on land and in water.
* [Riparian zones](https://www.qld.gov.au/environment/land/soil/soil-testing/soil-terms) are particularly at risk as they occupy the lowest parts of the landscape where much of the saline groundwater is released to the surface. Salts also help fine materials (such as suspended clay particles) to flocculate, allowing more sunlight to penetrate rivers. This may lead to more [harmful algal blooms](https://www.qld.gov.au/environment/water/quality/algae) if there are suitable environmental conditions.
* Much of the natural vegetation of salt-affected areas has been destroyed or damaged. This has caused major changes to the landscape and biodiversity including the destruction of remaining natural habitat in many agricultural areas and the fragmentation of many wildlife corridors.
* How could the increasing salinity of Australian soil impact on agriculture?

There are also many off-farm impacts of salinity, the most significant of which appears to be the salinisation of rivers which affects drinking and irrigation water (for example in Western Australia some surface water is already too saline for domestic use) (NLWRA 2001). Other impacts are the damage to infrastructure such as road pavement, bitumen, pipelines and concrete. In 2000, some 1,600 km of rail, 19,900 km of roads, and 68 towns were at risk of damage due to salinity.

In 2000, 5.7 million hectares of Australia were assessed as having a high potential to develop salinity. Predictions indicate that unless effective solutions are implemented, the area affected could increase to 17 million hectares by 2050, most of which is agricultural land (more than 11 million hectares) (NLWRA 2001). In 2002, about 20,000 farms and 2 million hectares of agricultural land showed actual signs of salinity (ABS 2002). For many farms, salinity has meant loss of productivity and income.

* What social problems will result if the salinity of the soil continues to increase in Australia?
* Impacts include large decreases in the lifespan of road pavements when groundwater levels rise to within 2 metres of the pavement surface.
* As in other situations, [capillary action](https://www.qld.gov.au/environment/land/soil/soil-testing/soil-terms) will assist to draw the salt-laden water to the surface.
* Salt also corrodes and destroys the properties of bitumen, concrete and brick structures.
* Damage to infrastructure including houses, roads and playing fields, has been particularly high in a number of cities and towns.
* Salinity damage has also occurred to country roads and farm tracks and buildings.

Salinity can also affect people directly in a number of ways including:

* cost to rural communities of declining population
* loss of business (both existing and potential)
* cost of rural restructure when farms become unprofitable
* increased health problems due to stress on families affected by change.

Salinity increases repair and maintenance costs for a range of services provided for public use as there is a need to replace infrastructure earlier than normal.

Road and bridge damage caused by shallow, saline groundwater is a major cost and many towns also experience damage to footpaths, parks, sewage pipes, housing and industry. The current cost in Australia is approximately $100 million to repair infrastructure damage caused by salinity.

These relate to the additional costs incurred by the community to minimise salinity and rising watertable problems. Examples of this include the costs associated with preventive measures like:

* purchasing rainwater tanks
* installing sub-surface drainage
* using higher-specification materials during the construction of roads and buildings to increase tolerance to [waterlogging](https://www.qld.gov.au/environment/land/soil/soil-testing/soil-terms) and salinity.

As an illustration, the annual costs to maintain a sports oval may increase by 25% (or more) when the oval is affected by highly saline [water tables](https://www.qld.gov.au/environment/land/soil/soil-testing/soil-terms).

The estimated cost of the loss in agricultural production from salt-affected farms is approximately $130 million (across Australia) and rising.

* It is a tragic irony that the felling of many billions of trees to make room for the farming that let this nation prosper has caused, in just 150 years, our worst environmental crisis, and destroyed a natural balance that had existed for millenia.
* Now farmers are frightened as they watch their farms degrade, billions of dollars are being lost, and scientists are admitting for the first time that there are no practical answers yet. It's little wonder, because the problems go well beyond agriculture. Dryland salinity also causes serious damage downstream from where the clearing has happened. Aquatic ecosystems are suffering, as is biodiversity and even urban infrastructure as saline groundwater rises in country towns and attacks foundations, roads and bridges.
* Salinity may also indirectly affect people by reducing the quality of the natural environment (for example, where the numbers and variety of wildlife decrease in salinised natural wetlands).
* What is Australia doing to reverse the changes it has brought about to the environment and help increase the sustainability of its ecosystems?

Salinity is one of the most significant environmental issues affecting South Australia. It is a priority for government and the community. Many projects have been started to try to address the problem. Some of the things that people have been doing include:

• constructing drainage channels,

• fencing remnant native vegetation,

• revegetation,

• protection of wetland areas, and

• planting salt-tolerant pasture on salt-affected land.

The NSW Government is working with the Australian Government, local government, farmers and the broader community to treat and prevent the different types of salinity.

The key to addressing dryland salinity is managing excess water in the landscape. This can be done by:

* maintaining adequate vegetation cover
* maximising water use by choosing an appropriate mix of pasture species
* minimising long fallows, using crop rotations and conservation farming methods in cropping areas
* maintaining soil health (fertility, pH and structure) to maximise plant growth.

Under appropriate conditions, salt-affected sites can be treated by:

* keeping stock off the area to allow regrowth
* applying mulch to reduce erosion
* planting salt tolerant grasses, herbs, shrubs and tree species
* adding gypsum and/or fertilisers to help plant growth
* preventing erosion by using contour banks to direct surface water away from the site
* reducing waterlogging by establishing banks and subsurface drains to intercept shallow subsurface water and direct it away from the site
* pumping groundwater to lower the water table.

Urban salinity needs to be addressed at the local level and across the relevant catchment. This is because groundwater is affected by actions at both levels.

At the catchment level, prevention involves managing the land as described under [**dryland salinity**](http://www.environment.nsw.gov.au/topics/land-and-soil/soil-degradation/salinity/type-of-salinity-and-their-prevention#drylandsalinity).

At the local level, councils and residents should:

* avoid overwatering public parks, sports fields, home gardens and lawns
* plant large native trees and shrubs in open spaces
* replace leaking channels and pipes with corrosion-resistant materials
* minimise groundwater recharge from dams, artificial lakes and drainage basins
* drain water away from infrastructure to avoid ponding
* connect septic tanks to piped sewerage systems where possible
* connect roof drainage to stormwater systems rather than sullage pits (a pit holding the used water from washing clothes and kitchen utensils)
* monitor changes to water table levels and groundwater quality
* establish gardens with low water requirements.

<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1370.0~2010~Chapter~Salinity%20%286.2.4.4%29>

<https://www.qld.gov.au/environment/land/soil/salinity/impacts>

<http://www.abc.net.au/science/slab/salinity/>

<http://www.abc.net.au/science/slab/salinity/>

<http://www.abc.net.au/science/slab/trees/story.htm>

<http://www.epa.sa.gov.au/soe_2008/resources/education/dry_land_salinity.pdf>

<http://austhrutime.com/lake_eyre.htm>

<http://www.water.wa.gov.au/water-topics/water-quality/managing-water-quality/understanding-salinity>

<https://www.dpaw.wa.gov.au/images/conservation-management/salinity/salinity-strategy.pdf>