GEO 328: River Conservation and Management

1. INTRODUCCTION

This coursework is going to speak about the attempt of rehabilitation of a part near the Tyne Riverside Country Park called Throckley pond which is hardly polluted by an old coal industrial activity. Throckley pond is localized near the Tyne Riverside Country Park, in the west edge of Newcastle. Here we have attached a map of this zone:

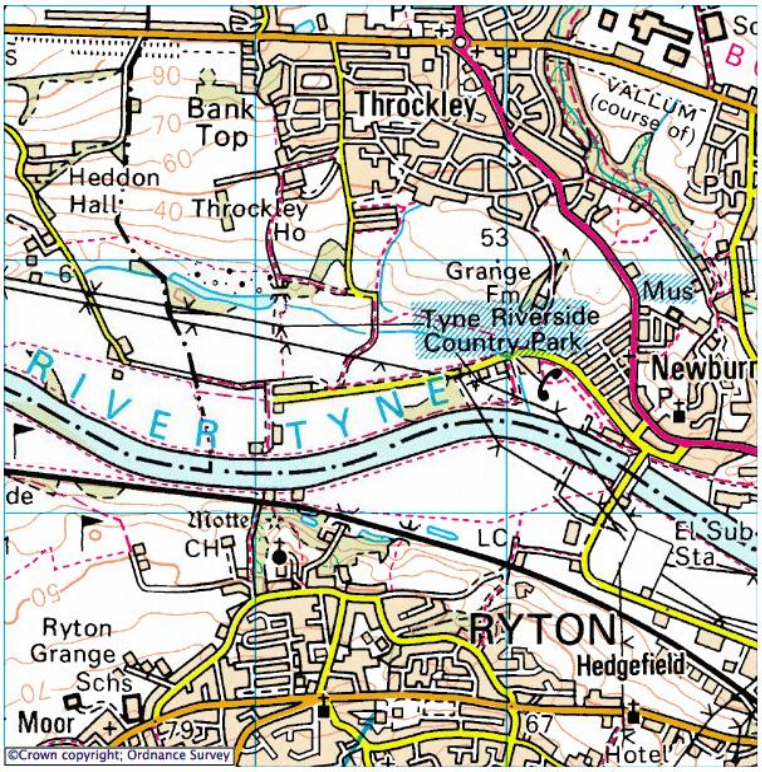

Figure1: Map of the study area

The main aim of this coursework is to offer an alternative/s to recover the ecosystem, as it was before the industrial revolution that has caused so many problems in this area. This process of recovery is not only based in the cleaning up of the water, we should be able to recover the entire ecosystem, even though it is very difficult, we have to try to recuperate most of it. Because the aim of this coursework is to make recommendations for the practical rehabilitation of degraded riverine habitat for the Reigh Burn and it would be good to remind that this does not only include water quality, also vegetation, animals, sediments, etc. So if we are able to recuperate also the habitat, this will be for the benefit of the water quality. And at the same time, water quality is going to affect to the habitat.

As we could see during the fieldtrip we made in October to this place, there is a main problem against our interest of recovery in this zone: There is not flat space enough to try to apply the different alternatives that are available. The floodplain is quite narrow and is occupied by others activities like farming. So we have to be very careful with our selections because maybe it is not impossible but it can be very hard to realise because that alternative needs too much effort.

We can choose between different alternatives but all of them must be as natural as possible. This means that

we have to avoid building big edifications that can promote more damage than the properly problem that we are trying to solve. So in this case would be appropriate to use techniques like plants, buffer zones, etc

But firs of all, and before go to the alternatives, it is very important to know how we are going to design the project and which steps are necessary. So before let us pay attention to the methodology we should follow.

2. PROJECT

Taking as example some projects carried out in south−west Germany, we can take some ideas of how orientate our coursework and which steps should be taken until get the final idea of rehabilitation of our stream.

- **Planning steps**:

The successful rehabilitation of channelized watercourses needs an intensive interdisciplinary planning process. Before starting to design the project, the feasibility of it has to be investigated according to some criteria:

♦ Evaluation and plausibility:

It does not make sense to spend a lot of money for the restoration of a 500 m section which is followed by a 300 m closed conduit.

♦ Water quality:

When a stream is polluted is better to localize the sources of the pollution than orientate our efforts to try to improve water quality.

♦ Objectives:

The main objective is the conservation of nature but depending on certain criteria other ones can be also representative like the demand of recreation, especially if the watercourse is near of settlements.

♦ Participants:

All the institutions affected have to participate, even if they are private. And on consultant's side, different specialists must be consulted depending on the specific requirements.

- **Data collection:**

We have to know the stream history and its present condition, for this, we have five key topics as:

♦ Land use.
♦ Floodplain habitats must be assessed.
♦ Channel morphology and stream type must be described.
♦ There must be consideration of hydrological and hydraulic data.
♦ Limnological investigations are required.

- **The Leitbild concept**

The Leitbild concept is a description of the desirable stream properties regarding only the natural potential, without taking into account economics and political aspects. It is based in three elements:

- Natural stream properties
- Irreversible changes of abiotic and biotic factors.
- Aspects of cultural ecology.

From this ideal state of Leitbild towards the final rehabilitation concept, two more steps have to be taken:

- Optimal solution
- Feasible solution

Usually, some restrictions are imposed to the Leitbild, but the planners have to decide which parts and aspects of the project are essential to the ecological rehabilitation. This is the *optimal solution*. This idea must be discussed with all the participants. After it, some alterations are imposed by the legal procedure. The final project design may be called the *feasible solution*.

- **Monitoring programme:**

In order to control the results of the restoration efforts, a monitoring programme was established covering stream bed morphology, limnology, vegetation and faunal groups. These all elements are measured with three or four field observations over a ten year period after structural restoration. As yet there are no precise results but we can fin three tendencies:

- Rapid morphological changes can be expected in the first years after completion.
- Vegetation can be dominated by exotic species suppressing domestic potential vegetation.
- Fish population will not significantly change in the early years.

Of course, this will be the way to follow if we were really trying to design the project, so this should be an example of how to design a project properly. Now we are only to give the ideas that could be possible taking into account the reality, the different natural characteristics of the area, with its benefits and its constraints.

3. CONSTRAINTS

Apart of the ones that come from proper environmental laws, there are another ones like Agenda 21. It would be better if all of our possible options will be respectful with the postulates that are showed in this global agreement that was signed in Rio, 1992. One of the most important affirmations and the one which affect us more directly is the one which we can find in the Agenda 21 in the section 2 **PROTECTION OF THE QUALITY AND SUPPLY OF FRESHWATER RESOURCES: APPLICATION OF INTEGRATED APPROACHES TO THE DEVELOPMENT, MANAGEMENT AND USE OF WATER RESOURCES**, chapter 18, point 2:

Water is needed in all aspects of life. The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water−related diseases. Innovative technologies, including the improvement of indigenous technologies, are needed to fully utilize limited water resources and to safeguard those resources against pollution.

Source: UNSD, 2000.

So we have to take into account these statements in which are resumed most of the main aims of the new water culture. These are not the only sentences important for our coursework but this article resumes quite well how it has to be our behaviour under the new possible projects affecting fresh water across the world, especially in Europe and certainly in the United Kingdom. One of the most relevant sentences is the one

which affirms that we have to preserve the hydrological, biological and chemical functions of ecosystems This shows us that all the ideas we have to recuperate the Reigh Burn. It is our duty to try to restore this area to its original state as it is my belief that we do not have the right to disturb nature balances. During the industrial revolution, significant changes to ecosystems, such as the one I am studying, occurred which adversely affected much animal and plant life. With this hindsight we should be able to learn from the past errors and now have the responsibility to avoid such problems occurring again.

Definitely, all of our intentions and ideas of recovering this part of England must be in tune with the considerations showed in Agenda 21.

4. ALTERNATIVES

The theoretical design that we have thought about, includes different systems and methods of rehabilitation. We think that it could be a good idea to try applying these different techniques in the zone because a complex system as the one we are working in, maybe needs also a complex plan.

4.1 Open the watercourse

As we could see during the fieldtrip in this area, all along the watercourse there were some structures that obstructed the water flow. So first of all we could improve these constructions with the aim of liberate the water in its way down to the river Tyne. A part of these structures, there were some aquatic plants that also made lose velocity to the water. So if we pull up this flora, water can flow quicker. One of the most important aims is increase water velocity, this way we can improve oxygenation in the water, so at the same time we get better water quality.

4.2 Reed Bed Treatment Systems

Reed bed treatment systems are self−contained, artificially engineered, wetland ecosystems. They are designed to optimise the microbiological, chemical and physical processes naturally occurring in the wetland. Wetland plants, such as reeds, transfer atmospheric oxygen down through their roots in order to survive in waterlogged conditions. This creates both aerobic and anaerobic soil conditions, allowing extraordinary microbial species diversity to flourish. These bacteria and fungi can use organic pollutants as a food source, breaking down a wide range of organic chemical products. One of these bacteria that can develop and be useful in this type of polluted rivers are *Pseudomonas*. The treatment of the contamination originated by the accumulation of heavy metals is also possible with the utilization of some kind of these bacteria. The toxic effect of the heavy metals is used to being associated to the presence of ionized forms (cations) of the metals in question. Certain bacteria present enzymes capable to reduce the metallic cations to the neutrals forms that are less toxic. We can also use another kind of bacteria as those know as *Zooglea*. These bacteria concentrate heavy metals in big aggregates that after its aggregation, are precipitated. So, chemicals products are not always simply stored in the reed bed; they are actually degraded into harmless components. Other contaminants, such as metals, are transformed from a toxic, mobile state and fixed in the soil via complex chemical reactions. Soils adsorption capacity also provides a buffer for peak or shock effluent loads.

(Ocean ESU global environmental services & UPNA)

Reed bed systems offer a number of significant benefits. They save costs, are easy to operate, and they are also environmentally safe. We could install one of these reed beds near the pond.

4.3 Meander re−instatement

This technique consists in recuperate the old channel form to improve habitat for aquatic plants and animals by restoring natural alignment, channel capacity and meander relationships. So instead of a straight channel,

we will construct different meanders along the channel. Reconfiguration of the channel path can be set following established concepts (Brookes, 1984) or it may be copied from a historical records. Anyway, a meandering channel by definition is one that has a length at least 1.5 times the length of the down−valley distance, where a straight channel has a length of 1.00 (Leopold et al, 1964). The benefits of a meandering channel are different but we can recognise those ones: flow transports sediment from the concave bank to the nearest convex one. This process also dissipates its energy and in its turn the erosion. Speaking in habitat terms, this kind of channel provides complex faunal and floral communities, in general meandering channels offer more habitat diversity than is typically found in a straightened stream corridor. And also the water quality can increase, because the longer time the water stays in the system, the longer the system can filter it with the different chemical interactions. (Petersen, 1992)

We have to keep in mind that the river is not only water flowing in a channel. First of all, we should know all of the catchment is a system so there are different and many links in it, where water plays an important role. Relationships between the channel and its banks are really essential for the health of the river. So if we have a straight channel water is going to flow quickly, without time enough to try to establish these relationships along the channel.

Figure 2: Stream meander restoration perspective view

Source: USDA & NRCS

One of the most important elements that are flowing in the water are the nutrients. These elements are vital for the living creatures, they need them to run their vital processes. These nutrients are the base of the food chain and from this point they start to expand along the system. That is why there are so important, they are the base of everything. This is the reason why we have to keep in mind that the interactions between the different chemical elements are going to affect directly the river conditions in terms of water quality, biota, etc. As we know river interactions, not only the chemicals, occur along the river including both banks, here we can find two different aspects. First of all the distance, this parameter is quite important because as much as water flows along a natural, healthy catchment, water quality is going to be better since is going to suffer more exchanges. These type of interactions along the channel have as aim consequence: water purification, but this aspect goes against our interests because our work zone is a little catchment, then we have to be very careful with this aspect. Secondly, the state of conservation of the catchment, as much as rich is the catchment in natural terms as much as better are going to be these kind of relationships, but especially chemical ones. For example it is better to have a river with a well−conserved natural corridors, with wetlands, etc than an artificial straight channel surrounded by cement where no relations are possible. So only insist about the thing that these interactions are really important for the problem that we are trying to resolve.

The problem that we can find again is the space, maybe the meanders we will try to reinstall will be quite small because this sub−catchment is little.

4.4 Buffer strips

The strip of land between the stream channel and the surrounding landscape is called buffer strip, riparian zone, corridor,etc. The functions of this area are principally to retain and reduce nitrogen and phosphorus, stabilize the banks along the stream and create a complex habitat which traps and retains sediments coming from the fields. Not forger other kind of functions, like new habitat for the non−aquatic animals. Fortunately, the state of conservation of these species is not as bad as the aquatic ones as we can see in the handbook

While the functions are more or less know, that is why is one of the best ways to improve and recover the natural landscape that was before the industrial revolution and all its pollution, it is not very clear how wide buffer strips should be. The values will most likely be different depending on the target we are looking for. For example if we want to control nitrogen levels with 10 metres in enough. The problem maybe is that we do

not have these 10 metres in this zone because of this reason that we have mentioned several times, the floodplain is too narrow. We have to look at this point carefully. However by any reckoning, this method of recovering is one of the most useful in these cases, so we do not have to forget about it. Apart of the water and habitat improvements, the instalment of this buffer zone is also important for the people because gives a view more natural of the river. The social impact will be definitely positive.

A very important aspect is that once we have created the buffer strip, it will revegetate naturally but it would be better if we help it introducing native species of riparian woody trees to accelerate the process of revegetation. (Petersen, 1992)

4.5 Side−slope reduction

One of the major sources of sediment and phosphorus to streams is the small gravitational movements that periodically occur along the length of a channelized stream. If we reduce the side−slope, first of all, the quantity of sediments that appear directly in the watercourse is reduced; secondly, the width of the channel increases allowing the stream to dissipate its expanding on to the floodplain during a peak flow. This technique is thought for when works of meandering re−instatement start because they will cause a great damage in vegetation and in some places along the banks, there is an important slope, being possible to provoke important erosion. So it is better to take into account this just in case.

4.6 Riffle−pools

Riffle and pools should be as a restoration building−block, where those sections of stream that have a steep gradient and coarse stream sediments exist. Like meanders (concave and convex) this forms should be designed to have one pair, a riffle and a pool.

The frequency of instalment it is a riffle and a pool at a downstream distance of five to seven times the stream width, for a stream 1m wide a riffle−pool pair should occur every 5−7m. Based on empirical hydrological evidence, the riffles should be about 3m long followed by a 2m long pool. But according with one of the handbooks gave in one lecture, the size of riffles is typically 15% larger than that of the pools, anyway this difference is not very big and it will depend on the river we are working in. And riffles should be 300−500 mm above the natural gradient and the minimum depth of a pool is around 300 mm below low−flow level.

Alternating riffle−pool sequences are an important aspect of restoring the habitat of small streams (Petersen, 1992).

Gravel riffles promote the formation of stable substrate in channels that have been modified or otherwise heavily impacted by development. Gravel substrate provides productive habitat for aquatic organisms and areas for fish to spawn.

Many channels in the developed world rivers have been modified to improve their capacity to convey storm water. This has most often been achieved by straightening the channel alignment o by other methods. But these practices of channel modification degrade the stream's water quality and destroys aquatic habitat.

One of the problems that we can find with this technique it is that is recommend to apply in the rivers where the gravel substrate was the original and after was removed by different causes. So before to consider seriously the alternative we have speak about, we should find out if our channel fulfils this prerequisite or not. Another aspect to take into account is the new riffle maintenance. According to some projects that have been carried out in Ohio (USA), we have to inspect the riffle after the floods during the first year and once a year thereafter.

We should also look along the gravel riffles for any erosion that may be occurring. If it is determined that are

redirecting stream's energy into the adjacent bank, the riffles will need to be modified in order to avoid further stream−bank erosion (ODNR, 2001). Once we have deleted all the artificial obstacles, it is very important to install any kind of riffle and pools, to improve water and habitat quality.

4.7 Riparian wetlands/swamp forest

Along a catchment there are some areas which are seasonally difficult for the farmer due to excess water. These swamp are usually former wetlands or swamp forests. Their main benefits are wildlife conservation and nutrient retention ability.

If we are thinking about using this alternative, we should know that it is better to establish these areas all along the riparian corridor than at the freshwater/marine interface because they can carry out better their functions. (Petersen, 1992) Apart on the special localization of the wetlands, we have to choose the most suitable one between a variety of them to satisfy our demand, if it is necessary. As we have limited our search to those one localized along the riparian zone, we only have to choose if we want some small wetlands or a bigger one. It will depend on the characteristics of the river. I think we could install one of them in, at least, one place along the watercourse.

5. SUMMARY

The area of study is a place quite polluted that we have to try to recover it with some methods as much natural as possible. Full rehabilitation of this ecosystem is quite difficult but with time and suitable techniques maybe it is possible to get this important objective. So we should take into account different aspects like the habitat (aquatic and non−aquatic) and the water quality. Showed alternatives should be enough to restore these aspects.

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