Wasserwirtschaftsamt München

Landeshauptstadt München

Improved protection against flooding

A new lease of life

Development of a more natural river landscape

for the Isar River!

Better recreational quality

From wild river to cultural landscape

To the Celts, the Isar was known as "the torrential river". And indeed, at the beginning of the nineteenth century, it was a typical wild alpine river with wide gravel islands and sandbanks and a constantly changing river bed. Handicraft businesses made use of the river's hydraulic power via a series of canals. But after repeated flooding suffered by the Lehel, the Au and the Thal district, the river was straightened in the mid-nineteenth century and forced into a tight corset. Through the use of dykes, floodplains, walled river banks, weir systems and the works canal, the water's power was able to be exploited. For more than 100 years, the Isar flowed through the city via a system of canal-like waterways.

The "Isar-Plan" – planning, implementation and results

In the 1980s and 1990s, calls for a more natural environment in the "corrected" stretches of river became louder. Having, on the one hand, established that parts of the region did not comply with the new flood protection standards, and with the growing need for recreational spaces on the other, the idea of one major project to solve both sets of circumstances seemed like the best solution. In 1995, the project group "Isar-Plan" was initiated. It was to be headed by the State Office of Water Management Munich (Wasserwirtschaftsamt München) and to include representatives from the Department of Public Construction (Baureferat), the Department of Urban Planning and Building Regulation (Referat für Stadtplanung und Bauordnung) and the Department of Health and Environment (Referat für Gesundheit und Umwelt). The level of cooperation achieved within this group was excellent and, as yet, unparalleled. An interdisciplinary project group and a panel of experts, which included representatives from the district policy committees and the "Isar-Allianz", assisted and accompanied the project.

The "Isar-Plan" is a joint project managed by the State of Bavaria and the City of Munich. It is headed by the state, and represented by Munich's State Office of Water Management. In a resolution passed by the city council in 2000, the city's Department of Public Construction was assigned responsibility for the project. Since then, it has assumed responsibility for all costs, deadlines and quality-related aspects for the City of Munich as a project partner.

Development goals

The working group examined the flood-water situation, the need for recreational areas at the riverside, and the area's animal and plant worlds and their habitats. Based on their findings, they defined the following development goals:

- Improved protection against flooding
- Development of a more natural river landscape
- Improved recreational quality

One of the project's main challenges was to maintain a balance when implementing the various measures. No individual goal was to be forced through at the expense of another.

After a construction phase of 11 years, these goals have now been achieved.

The Isar in Munich

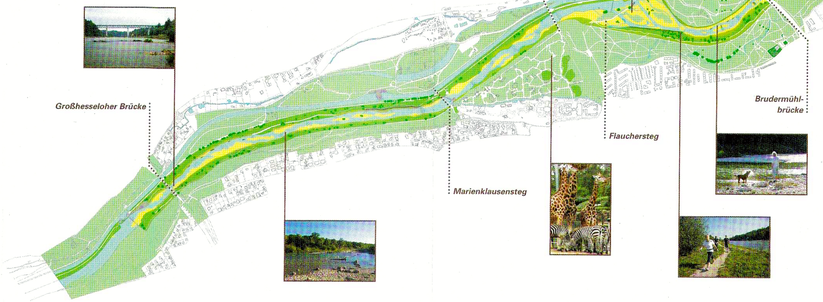
If you go for a bike ride or a walk along the Isar, from the Grosshesseloher Bridge to the Deutsches Museum, you will notice the transformations underway. The river landscape's changing face and the increasing influence of humans on the area are clearly recognisable.

Natural areas, urban landscape, river

The area's southerly parts feature steep wooded slopes that lend a near-natural character. Closer to the inner city, the region is typified by "Gründerzeit" (late nineteenth century) buildings, bridges and embankments.

In order to fulfil the high technical, ecological, societal and design requirements involved in redesigning the urban area between Braunauer Eisenbahnbrücke and Museumsinsel, a competition was held. Teams from the fields of landscape architecture, hydraulic engineering and urban planning were invited to take part in the competition, which was to be followed by a public-participation aspect.

The design of the various areas needed to suit the respective environments, from the near-natural south to the more urban central Isar region. Today, this stretch of the Isar is a more natural river landscape with gravel banks and a wild river ambience. Where possible, this wild character has even been achieved in the more urban areas.



Recreation and relaxation

With its islands, gravel banks, flowering meadows, wetland forests and parks, the Isar region is an attractive recreational area for the whole of Munich, and particularly for the almost 200,000 people living in its neighbouring districts. The area is ideal for bike rides, leisurely walks, jogging, sunbathing, barbecuing and playing games. In the winter, you might even be able to go cross country skiing here.

Flood protection

In Munich, flood water can run off without causing damage at a rate of up to 1,100 cubic metres per second. In order to better protect lower-lying city districts from extraordinarily high flood waters and the associated damage, an additional safety distance of one metre between the flood water level and the crest of the dyke is necessary. This flood protection measure will be achieved primarily through widening the riverbed and by raising the dyke height where this is deemed necessary.

Water and living space

Water quality

The degree of effort that went into achieving bathing-water quality for the Isar was unmatched in Europe. All communities situated on the Isar, from Mittenwald to Freising, and including the city of Munich, have completed the process of upgrading their waste-water treatment plants to include UV germicidal irradiation systems. These measures have considerably improved the quality of water.

Today, swimming, boating and windsurfing in the river's waters is only restricted by the bathing and boating by-laws (Bade- und Bootsverordnung), which prohibits such activities in areas classified as danger zones.

Water power and residual water

For much of the year, the use of water power for urban purposes meant that only a small volume of water passed through the Isar. Today, the amount of residual water has been increased. Indeed, it adapts dynamically depending on the time of year. This results in more water in the Isar during the summer and less in the winter. The effects of this development on the region's water quality and living spaces have been highly beneficial.

Water and land habitats

The widening of the riverbed not only led to an improved flow of flood water, but also created room for development and design measures on the banks. Gently sloping riversides, gravel banks off the shores, gravel stone islands and ground ramps made from large blocks of flat stone and interspersed with deeper pools; features such as these lend today's Isar region its natural character. The project measures have also seen an improvement in living conditions and habitat variety for the Isar region's native animals and plants.

The new Isar – an all-round gain

Completely restoring the river to its original wild state is not an attainable goal. But step by step, a natural river landscape has been successfully developed that is able to offer people considerably improved recreational value.

How the Isar was turned back into a river

The channelled riverbed was extended, and the riverbanks levelled and redesigned to give them a more natural character: areas of shallow water and deeper pools, rapids and calmer areas of water were integrated. The existing tree population on the Isar's dykes was maintained to the greatest extent possible.

The future now lies in Mother Nature's hands

Gravel banks, gently sloping riversides and small islands were created. In the northern section, the river banks were terraced. But these measures are only the beginning and are designed to trigger a development process: they assign the most important task to the Isar itself, allowing it to evolve into a river within set limitations.

Versatile flood plains

The popular flood-plain fields still provide an excellent location for sports and other recreational activities. Indeed, the area's recreational value, the views of the river and the accessibility of the riverside areas have all improved. The open feel of the landscape has been maintained. Today, being able to relax at the water's edge is a reality.

A major project has been realised

Construction began in February 2000. And over the course of eleven years, the "Isar-Plan", comprising an eight-kilometre stretch of river, has become reality. The Isar River now has more room to move and reshape itself along this entire stretch. Where possible from a landscape and urban perspective, it boasts flat, accessible gravel banks. And the Isar's Alpine origins are once again apparent. With every flood, the river can reshape its shores and shift its gravel banks which, in turn, create new habitats for the flora and fauna native to the Isar region.

How valuable is the Isar to us?

The costs of the flood protection and renaturation measures implemented on Munich's Isar River amounted to approximately 35 million euros. These costs were borne by the State of Bavaria (55 %) and the City of Munich (45 %). They include all hydraulic engineering measures, such as the laying of supply lines and the removal and disposal of Second World War debris uncovered during excavation work.

Project figures

- Length: approx. eight kilometres
- Construction period: from February 2000 to June 2011
- Costs: approx. 35 million euros (28 million euros in construction costs, seven million euros for the remediation of contaminated sites and the removal and disposal of weapons from the Second World War)
- Cost distribution:
  State of Bavaria 55 %
  City of Munich 45 %
- Number of rough ground ramps: 24
- Approx. 2,000 square metres of mixed-in-place walls
- Approx. 385,000 tonnes of incorporated riprap stone
- Total volume of excavations approx. 710,000 cubic metres
  = approx. 1.3 million tonnes
  = approx. 60,000 truckloads
  = approx. one continuous line of trucks stretching from Munich to Lake Garda

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Flood protection – here's how it works

Improving flood protection was achieved primarily through widening the river bed, installing new riverbank protection measures and implementing complex dyke restoration plans. The process of levelling the riverbanks not only resulted in better flood protection, but also contributed to nature conservation and enabled people to access and experience the river.

RIVERBANK

River bank protection measures

A certain level of protection for the new, levelled river banks is essential in order to prevent the Isar from reaching the dykes during flood periods, damaging them and flooding the residential areas located behind them. Measures to protect the river banks consisted of a fill layer of stones measuring approximately ten to 40 centimetres.

Within the limitations imposed upon it, the Isar can shape its riverbed and banks independently. Its waters can now shift the gravel back and forth, allowing the river's Alpine origins to manifest themselves. The region is thus becoming an exciting, dynamic place located in the midst of a densely populated city with over one million inhabitants.

In order to give the Isar back its dynamism, the river-bank reinforcement measures installed in alternating sections are not located directly on the shore line, but are built into a protective ditch set back from the bank. This ditch is filled with stones measuring between 20 and 60 centimetres and covered with earth. This constitutes the rear defence line for the "dynamically developing river bank", which the river can shape itself during periods of flooding. As shown in the photo to the side, the Isar made good use of its new independence:

steep bank washouts are just as much a part of the renatured river landscape as the easily accessible sloping river banks.

Hidden bank revetment: prefabricated river bank with filled gravel banks

Dynamically developing bank with reverse defence system (in this case in the form of a trapeze-shaped security ditch)

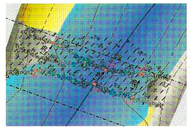
Dynamically developing bank after flooding

WATER

Ground ramps

A ground ramp serves to overcome varying degrees of steepness in a stretch of water.

The ground ramps installed in place of the cross-river sills consist of large flat stones embedded in a base of smaller stones measuring 40 to 60 centimetres and a filter layer of coarse gravel. Arranging the stone blocks in several bars and creating a honeycomb-like structure enables the individual bars to support one another. This, in turn, gives the system added stability. The pools created between the bars provide fish with cover, nurseries for their young and rest areas. This system serves to both protect against flooding and to prevent a deepening of the river bed.



Site plan of a ground ramp with bar construction: measures to convert the 30- to 60-centimetre-high cross-river sills into flat ground ramps will reduce the differences in steepness in a 12- to 20-metre stretch of river.

Ground ramp under construction: the staggered structure consisting of bars and pools is clearly recognisable. The base consisting of stones measuring 40 to 60 centimetres under the large stone blocks is also clearly visible.

DYKE

Restoration of the dykes by means of filling

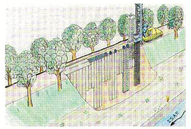
Trees growing on dykes pose a danger to the dyke's stability and can cause ruptures, particularly if the dyke is soaked through as a result of flood waters. This weak spot can quickly lead to the dyke's bursting.

Measures to fill in the dykes served to both improve their stability and to preserve the valuable old avenue trees growing on the crest of the dyke.

Dyke reinforcement by means of mixed-in-place walls

In some special cases, the following complex procedure was implemented: using a heavy-duty drill, a slit of four to five metres is cut from the dyke crest into the ground. The layers of earth are then mixed with a suspension of cement and bentonite clay. This hardens to form the dyke wall – an effective method of protecting the dyke from bursting. And it was thanks to this process that the old tree population could be preserved.

Dyke filling measures in order to preserve the existing tree population



Hidden mixed-in-place wall

The Isar revitalised!

The renaturation of the Isar has been an all-round success. Today, the river landscape again provides a habitat for flora and fauna. Plants, wild herbs and beetles threatened with extinction have been returning to live in the renatured river bank areas, in the water and on the dykes.

Gravel bank inhabitants

The northern dune tiger beetle is a typical inhabitant of the gravel flats.

The little ringed plover is an indicator of a natural, wild river environment.

And the blue-winged grasshopper is a typical pioneer species in alluvial areas.

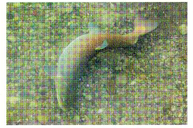
The German tamarisk tends to grow in fresh river gravel and is an indicator of an intact, wild river landscape.

The mountain avens is a species of pioneer plant that likes to inhabit coarse gravelly areas.

Fish typical to the Isar

The Isar's typical fish inhabitants are at home in fast-running, cool, oxygen-rich waters with a well-structured riverbed to provide them with a habitat and protect them from fish-eating predatory birds. Many of these fish, particularly the grayling and the nase, need a radius of 20 to 40 kilometres for their spawning migrations.

The grayling is the main fish in both the Isar and in regions to the south of Munich.



The huchen or Danube salmon is the Isar's largest fish.

The nase is particularly important in terms of providing food for the huchen.

Dyke inhabitants

The smooth snake loves warm raw-soil ground. Hollows under the stones of the bank-strengthening structures serve as their winter quarters.

Viviparous lizards and sand lizards love the gap-filled neglected grassland slopes, the surfaces created by river pebbles and other arid biotypes.

The endangered dragon's teeth plant is a light-seeking pioneer species that likes dry, warm soil.

The Idas blue can be found in the meadows around intact wild river landscapes.

The Isar River presents its new face

Before – after

Today, the Isar River offers people much improved recreational value. The Isar's transformation into an attractive river landscape becomes clear if you compare it with its pre-restoration state.

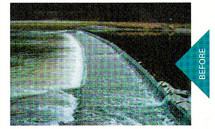
Isar river banks prior to restoration

Steep, inaccessible stone banks, canal-like, monotonous shoreline prior to renaturation measures

Isar river banks subsequent to restoration

Post-restoration, the Isar is typified by gravel shorelines and banks, inlets and islands on the riverbed. It can now change and adapt with every flood. Its shoreline consists of both sloping banks and steep wash-outs and its gravel islands shift back and forth with the currents. The river's dynamism has been reactivated and a wild river landscape regained – right in the middle of the city!

Cross-river sills prior to restoration



The series of cross-river sills built into the river every 200 metres prevented the straightened river from eroding away at its bed and made it impossible for the fish to embark on spawning migrations. In periods of low or medium water flow, they turned the Isar into a chain of dammed ponds.

Cross-river sills subsequent to restoration

Flatter, rough ramps have replaced the previous cross-river sills. Consisting of pools and a structure of stone block bars, these ramps provide the riverbed with sufficient protection while offering fish and other water organisms passable structures within which they can live and rest.

The dykes prior to restoration

The old dykes were too narrow and too low. They would not have been able to withstand an extraordinary, one hundred-year flood with 1,100 cubic metres of water per second. Moreover, their stability was further compromised by the trees growing on them.

Dykes subsequent to restoration

The new dykes are sufficiently high and wide. By reinforcing the dykes in front of the old embankments, the trees on the dyke crests were preserved. Flower-rich, rough pastures are developing on the new slopes.