John McLauchlan is the Managing Director of Viresco (UK) Ltd, a family run business based in Thirsk, North Yorkshire. The company sells specialist products into the horticulture and aquatic markets. Viresco™ Aqua and Viresco™ Koi are its microbial-based products for removing nitrate and suppressing blanketweed or other algae in ponds. www.viresco-uk.com

who's for a top up?

John McLauchlan looks at topping-up your koi pond. Should you use rain water or tap water?...

For almost 10 years, we have been selling microbial products under the brand name Viresco™ which remove nitrate in pond and aquarium water. The main reason for using these products is to supress blanketweed and other algae. Nitrate is the key nutrient ingredient because, when it is reduced to zero, algae, in whatever form, will die of starvation. However, a relatively small proportion of our customers use it because they know the condition of their fish is improved when the fish live in water with zero or very low nitrate content. As a result, we have regular feed-back from these people to say that their fish are healthier, 'happier' and are 'different creatures'. We also are informed that sores and flesh wounds heal up much faster when the nitrate level is taken down.

Rain - we've seen enough of it recently!

tapwater

Most koi keepers who have ponds with bottom drains remove organic waste in two ways. They will drop their bottom drains, releasing the waste matter with a relatively small amount of water. They will also use vacuums to lift out the dead organic matter from the bottoms of their ponds.

In addition, many koi keepers regularly change relatively large amounts of water – up to 10% or more at one time. When we ask the pondkeeper why he does this, we usually receive one of two answers. The first is to 'freshen up' the water and the second is to reduce the nitrate level. Most people do not appear to check the nitrate content of the tapwater they add to the pond. When they do, they can find that the water taken out is, say, 60ppm nitrate and the water that is going back in from the tap is 40ppm!

When we asked the Drinking Water Inspectorate what is the maximum allowable nitrate content of tap water is, they gave us a figure of 50mg/l (ppm) as their standard. However, many of our customers have told us that the nitrate content of their tap water is considerably higher than this figure.

Over the years, we have recommended that ponds be topped up using rainwater when the nitrate content of tapwater is relatively high. We have had, however, interesting feed back from some pondkeepers. Having used our Viresco™ product to keep their ponds clear of blanketweed, they have reported that blanketweed has grown back with a vengeance after a rainstorm.

Why should this happen? We are certain it occurs, at least in part, because of something we have all heard about. The key to this phenomenon is acid rain. I would suggest that most of us have not fully appreciated the significance of acid rain in keeping ponds.

Acid rain arises from two types of acid-forming materials. One is from sulphur dioxide that rises into the atmosphere primarily as a by-product of industrial processes and from the burning of fossil fuels. From a pond keeping and algae growth perspective, these sulphur products are not important. The second acid-forming group of gases that rise into the atmosphere are the nitrogen oxides. These include nitric oxide (NO) and nitrogen peroxide (NO_2). When these oxides (NO_x) are dissolved ` in rainwater high in the atmosphere, mainly nitric acid (HNO_3) is produced. This dilute acid falls to the ground when it rains and produces nitrate in ponds. The sudden rush into growth of blanketweed after a rainstorm is therefore explained.

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Another nitrogen compound that drops out of the sky when it rains is ammonia. It falls to the ground and into ponds as dilute ammonium hydroxide ($NH_4(OH)$). It is an alkali, not an acid and the amounts are generally less significant for pondkeepers than is the nitrate arising from nitric acid. It is interesting to see that ammonia, one of the products pondkeepers are removing from pondwater through their filters, can appear in the pond water when it rains as well as from fish excrement. In addition, the end product coming out of their filters – nitrate – can also enter the pond in rainwater.

the National Atmospheric Emissions Inventory

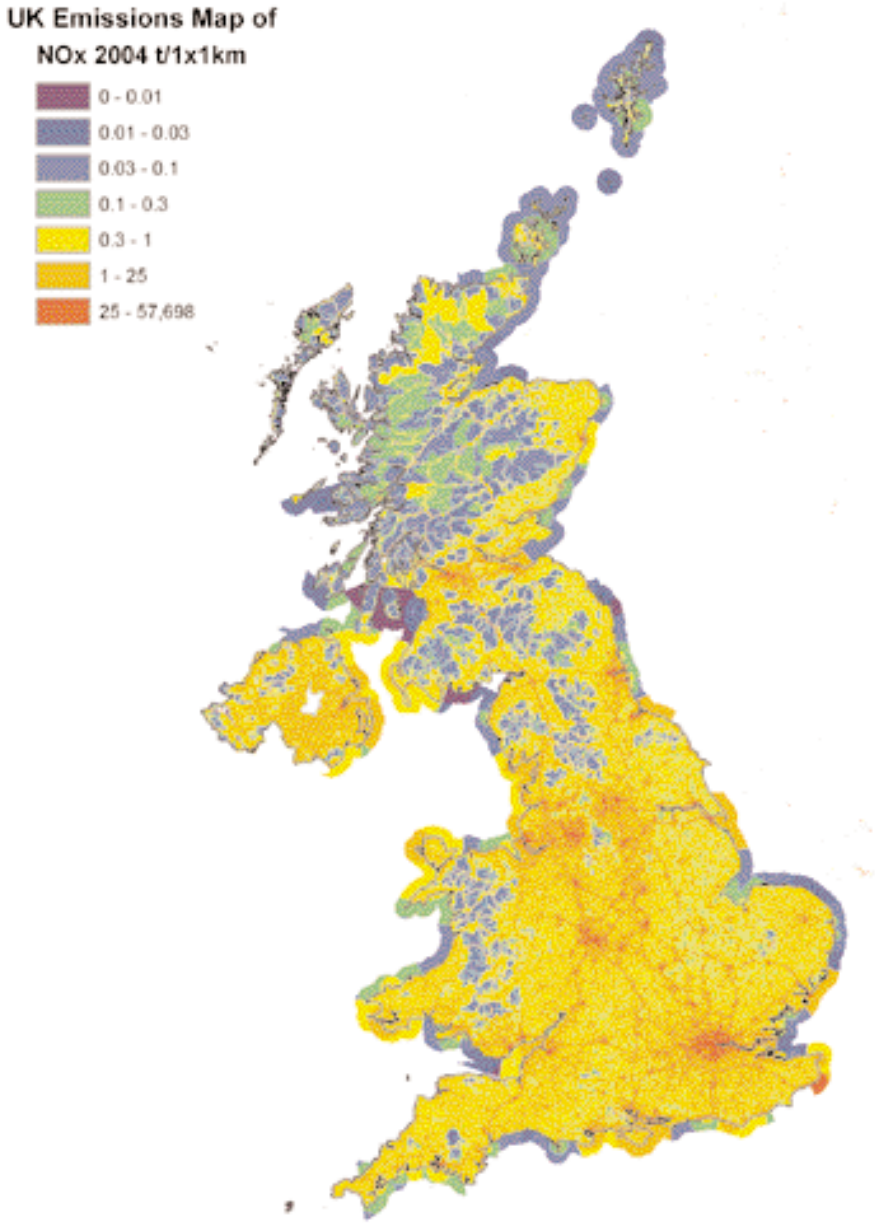
The website (www.naei.org.uk) of the National Atmospheric Emissions Inventory (NAEI) gives a good deal of information about the amounts and sources of various atmospheric pollutants.

Map of nitrogen oxides

Shown alongside, is a map of the UK giving the emissions of nitrogen oxides (NO and NO_2) for year 2004. The units are expressed in tonnes per square kilometre.

Also shown below is a bar chart that shows the source of these nitrogen oxides over time. It can be readily seen that a major source is road transport. Looking at the map, it is easy to see that the areas of the major roads and urban conurbations show up in red as the highest for nitrogen oxides emissions. The lowest areas for these emissions are shown in blue or purple. As one might expect, these areas are typically in the north-west of Scotland and along rural coast lines.

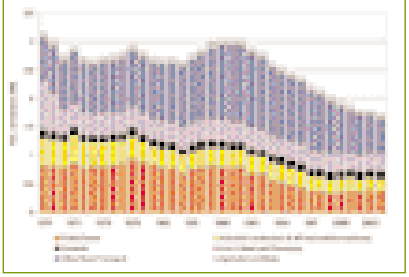
One weakness in this emissions data relates to the key. It shows seven different colours with six of these colours going from zero emission to 25 tonnes per square kilometre. However, the highest emission is shown as a bright red colour that has an emission range from 25 t/sq.km to 64,800 t/sq.km!



Bar chart of nitrogen oxides

Combustion processes also provide a significant contribution. Since 1970, overall nitrogen oxides emissions have fallen by 47%. Up to 1984 the emission profile was relatively flat with small peaks in 1973 and 1979. These were largely due to the cold winters in those years. From 1984, emissions rose significantly as a result of the growth in road traffic. This peaked in 1989 after which total nitrogen oxides emissions have declined by 45% as a result of a 55% decrease from road transport. This was due to the introduction of catalytic converters and stricter regulations and a 55% reduction from power stations. It can be seen from the bar chart adjacent that the main source of nitrogen oxide emissions from road transport. This sector contributes 37% to the total emission.

Nitrogen Oxides as NO_2



All the maps, bar charts and table are taken from the website of the NAEI and are Crown Copyright protected.

Evidence is there to show a sudden burst of algae growth can occur shortly after a downfall of rain

Another set of data that is available from the NAEI website is a table that shows the annual tonnes of different pollutants emitted from various large point sources situated within different distances from a particular postcode. Much of the data has been produced from models used by the NAEI although some have been provided by the owners of the plants in question.

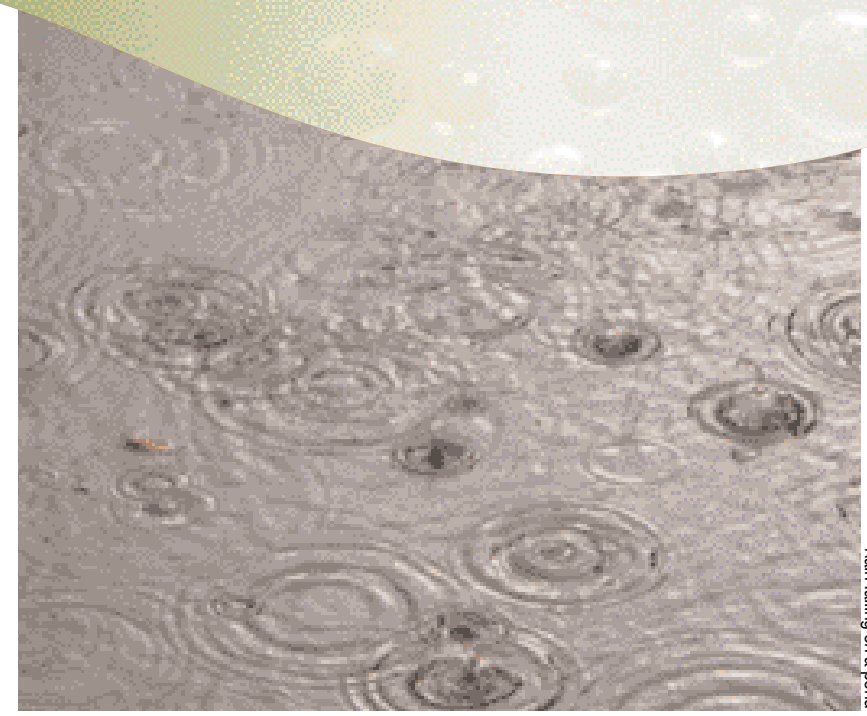
Pondkeepers can access this tool by going to www.naei.org.uk/mapping/mapping_2004.php and entering their postcode in the appropriate box.

An example is shown in the attached table, for which the average emissions around a BB5 postcode in semi-industrial mid-Lancashire in tonnes per annum per km2 from sources likely to influence the local air quality for a full range of atmospheric pollutants.

The table shows emissions from large point sources, usually emitted at higher levels through a chimney or elevated vent.

Sector 03 gives emissions from combustion in industry and sector 07 shows emissions from road transport. In the case of nitrogen oxides, the table shows 91 tonnes arising from industrial combustion and 13 tonnes from road transport out of 116 tonnes in total.

Our office is in Thirsk, North Yorkshire, and putting in our postcode, the nitrogen oxides emissions are only 39 tonnes. However, 28 tonnes of this arise from road transport emissions and only 0.35 tonnes come from combustion in industry.



Rain falling on a pond

One of our customers in the west of Scotland with a postcode starting with PA34 has an emissions level for nitrogen oxides of 0.27 tonnes per sq. km, of which emissions from industry are 0.0071 tonnes and, from road transport, are 0.21 tonnes per sq.km.

Another customer in Essex, with a postcode starting RM10, would find that the nitrogen oxides emissions above his home total 153 tonnes per sq. km. per annum. Of this, industrial combustion contributes 64 tonnes and 36 tonnes arises from road transport. The difference in nitrogen emissions between these two pondkeepers' homes is a factor of over 560 times!

Pollutant	Sector											Total Emission
	01	02	03	04	05	06	07	08	09	10	11	
1,3-butadiene	-	-	-	-	-	-	0.051	0.048	-	-	-	0.099
Benzo[a]pyrene	-	0.011	-	0.00039	-	-	0.010	0.0018	0.0012	-	0.020	0.045
Benzene	-	0.038	0.34	-	0.035	-	0.11	0.21	0.00020	-	-	0.73
Carbon Monoxide	-	8.3	19	-	-	-	45	42	0.38	0.014	0.84	116
Carbon Dioxide as C	-	1662	6172	-	-	-	697	93	-	0.17	0.82	8625
Lead	-	0.083	-	-	-	-	0.042	0.023	-	-	-	0.15
Nitrogen Oxide as NO2	-	7.9	91	-	-	-	13	3.9	0.0097	0.00041	0.028	116
PM10 (Particulate Matter 10 um	-	0.25	1.3	0.26	-	0.58	0.87	0.38	0.11	0.0028	0.13	3.9
Sulphur Dioxide	-	0.60	-	-	-	-	0.051	0.27	0.000038	-	-	0.92
Non Methane VOC	-	0.41	3.3	0.48	0.32	40	4.6	3.5	0.099	-	0.37	56

Most people do not appear to check the nitrate content of the tap water they add to the pond

The other pollutant that rains down from the atmosphere that could be significant to the pond keeper is ammonia. Again the NAEI have produced a map that gives emissions data for ammonia across the country for year 2004.

Map of ammonia

It can be readily seen that some of the areas of high ammonia emission differ greatly from the areas of high nitrogen oxides emission. This is because the greatest amounts of ammonia rise into the atmosphere from agricultural activities. From the map, it can be seen that ammonia emissions are high in Norfolk and Suffolk, a major region for poultry production. Other regions of high ammonia deposition are the rural areas of Northern Ireland and east and north Yorkshire.

A bar chart showing the sources and amounts of ammonia emissions over time is presented below.

It is also worth pointing out that the total emissions of ammonia are very much lower than the total emissions for nitrogen oxides. Total ammonia is approximately one tenth of the total nitrogen oxides. (See bar charts below and above).

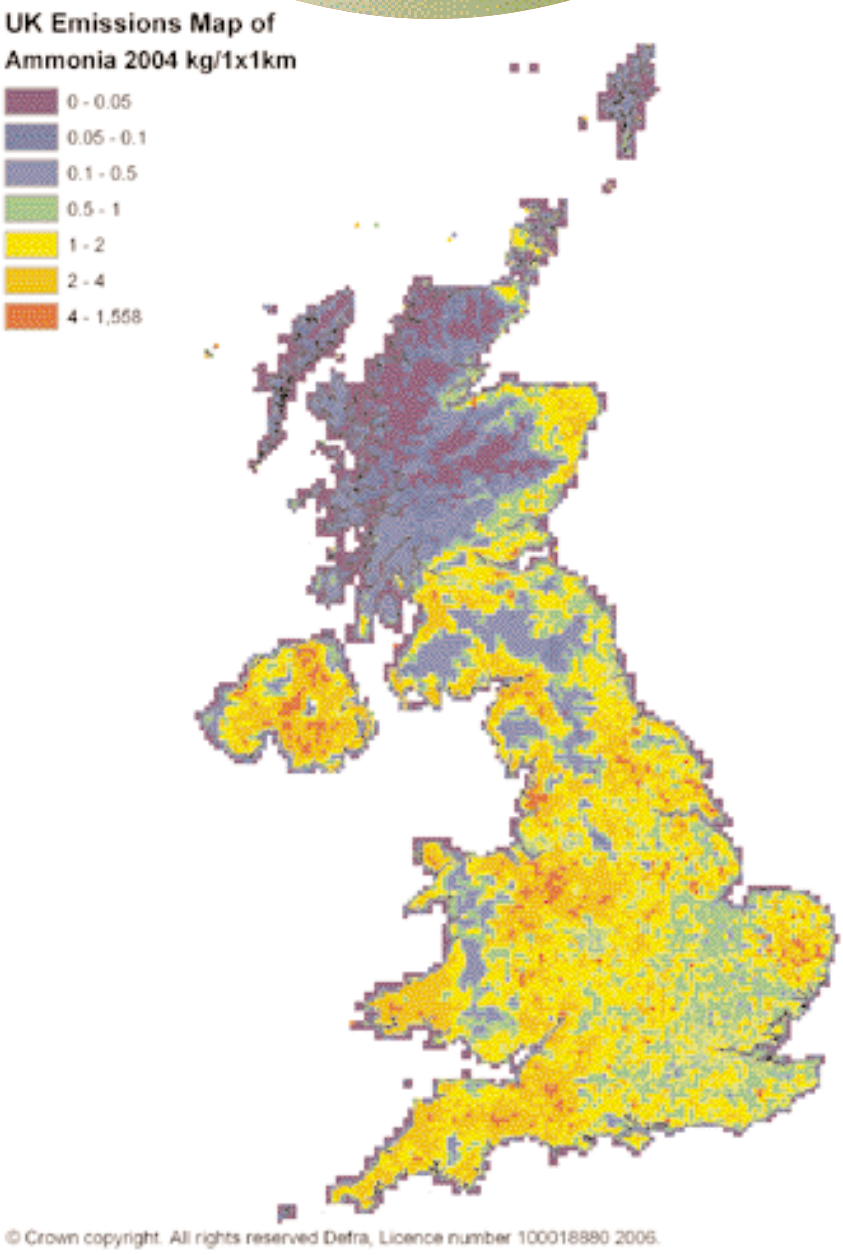
comments and conclusions

Let us take a figure of 100 tonnes of nitrogen oxides (NO_x) emissions per sq. km. per year. This converts to 1,000mg/litre (ppm) for a pond that is 10 sq. m. in area and one metre deep. These nitrogen oxides are converted by water into mainly nitric acid (HNO_3). The amount of nitrate (NO_3) entering the pond is approximately 50% greater than the amount shown as nitrogen oxides. Thus the total nitrate entering the water for the pond given above is going to be about 1,500 mg/litre (ppm).

I believe these major variations in nitrogen oxides and ammonia emissions across different areas of the country must make a difference in the way koi and other ponds are managed, in particular in

Bar chart of ammonia

Ammonia emissions are dominated by agricultural sources. Emissions from livestock and their wastes account for 79% of the total emission. These emissions primarily arise from the decomposition of urea in animal wastes and uric acid in poultry wastes. The amount of emissions depends on animal species, age, weight, diet, housing systems, waste management and storage techniques. The other agricultural sources included are emissions from fertiliser use, crops and decomposition of agricultural vegetation. Emissions of ammonia from road transport are rising as a result of the increasing number of three way catalysts in the vehicle fleet. Emissions in 2004 represent a decrease of 12% on the 1990 emissions.



Ammonia

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Many koi keepers regularly change relatively large amounts of water – up to 10% or more at one time

relation to blanketweed control. Most pondkeepers know that the level of nitrate in tapwater can be high. However, do they know that ammonia and nitrate can fall out of the sky in rain? Evidence is there to show a sudden burst of algae growth can occur shortly after a downfall of rain.

see for yourself

We suggest that pondkeepers go into the NAEI website – www.naei.org.uk – and look further into the emissions that might be personally affecting them by using their specific postcodes.

Going back to the original question of whether tapwater or rainwater should be used for topping up ponds, the recommendation is the pondkeeper should check particularly for nitrate (and other nasties) in both types of water sources and, if possible, use the one with the lowest content. You also have to bear in mind that levels may flutuate so regular checking is advisible. Better still, if the pondkeeper practises water changes to simply lower the nitrate level in the pondwater, then they need not change large volumes of water because pond products, for example Viresco™, are available that will take the nitrate level down to zero and hold it there. Once nitrate is removed, blanketweed and other algae stop growing. However, there is no subsitute for keeping on top of reguar pond husbandry. 鯉

Rain drop on leaf

A pergola can help to fend off the majority of the rain and provide some shelter for you and your koi too

The greatest amounts of ammonia rise into the atmosphere from agricultural activities