Rainwater Tanks in Schools Project: Learning Water Conservation from Corrugated Iron Sheet

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Abstract

Rainwater tanks have been an integral part of the Australian landscape. Yet, large cities including Sydney have not fully taken advantage of these simply structures. However, with the current water crisis and changes in climate, the importance of rainwater tanks for Sydneysiders is once again slowly recognized.

Kogarah Municipal Council became the first local government authority in Sydney to promote the use of rainwater tanks in all the schools within the council area. To facilitate this, Council in partnership with the Sydney Water Corporation has funded the installation of rainwater tanks in all the schools. The project also involved continuous simulation modelling to determine the appropriate tank volumes, based on factors including water usage patterns and available roof surface areas for harvesting. Numerous outcomes have been achieved from the project, not only in water savings but in fostering water conservation behaviour within the younger generation.

This paper provides an insight into Rainwater Tanks for Schools Project, highlighting the important educational role the project has played in increasing the awareness of Kogarah children with respect to water conservation.

Rainwater harvesting

Rainwater harvesting simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. The concept of rainwater harvesting is an age old one. Indians learnt this water arithmetic as far back as 5,000 years. The city of Dholavira of the Indus Valley Civilisation was harvesting rainwater even in the dry Thar Desert of western India (Kumar, 2000).

Over thousands of years, people living in various geographical and climatic regions of the world have evolved diverse, indigenous rainwater harvesting and management regimes as an adaptation to climate change. Some of these practices continue to remain in use even today. According to Pandey et al (2003), the antiquity of rainwater harvesting as an adaptation to climate change is intrinsic. In a fluctuating Holocene climate, rainwater harvesting by early human farmers may have been pivotal for emergence and diversification of food production.

Rainwater harvesting in response to climate extremes enhances the resilience of human society. In today's world that is confronting local and global climatic changes, building resilience of human society to absorb shock, and survive in the future would depend on the knowledge of the historical adaptive processes that are still functional, and rainwater harvesting is one such process (Pandey et al, 2003).

Rainwater tanks & Australia

Rainwater tanks have been an integral part of the Australian landscape. To the extent that during the opening ceremony of the Sydney Olympic Games, which was a window for the rest of the World to look inside the real Australia, we proudly displayed hundreds of galvanised iron water tanks. Given the vital role these tanks have played over the years in rural Australia, it was quite appropriate to celebrate them in such an important way.

Australian reliance on the rainwater tanks was so deeply entrenched that it took a fair bit of convincing by the Government of the day to make people connect to town's water supply system during the late 19th century (Coombes, 2002). For instance, citizens in the Hunter valley refused to connect to the permanent water supplies and, more importantly, pay for water from those supplies. The Walka water supply cost £350,000 to construct and £18,000 was needed every year to pay interest and operating expenses. In 1892 the local councils that administered the new permanent water supplies were in serious debt. The government did not have the power to force people to connect to mains water or to charge citizens whose properties were not connected (Coombes, 2002). The reluctance of the community to part with their rainwater tanks had threatened the economic viability of the emerging centralised water supply scheme. Consequently Government had to legislate mandatory fixed charges, which in turn ensured that citizens used mains water in preference to household rainwater tanks.

After a century of enforced implementation through legislative reforms and industry codes of practice, stormwater runoff from urban allotments is now collected in street gutters and pits, and conveyed to nearest waterways via pipes. Rainwater tanks have been all but driven out of the major urban centres in Australia. In fact, by the 1990s the use of a rainwater tank was illegal in urban areas. Local government and Water Authorities actively discouraged the use of rainwater tanks via stormwater drainage standards and informing citizens that they were illegal and dangerous (Coombes, 2002). The argument predominately used to discourage the use of rainwater centered on public health concerns. Coombes (2002) questioned these concerns while highlighting the limited published studies or data are in existence to justify this position. Indeed about 3 million Australians currently use rainwater from tanks for drinking with no reported epidemics or adverse health effects.

There has also been some debate about the volumes of water that can be provided from rainwater tanks. It is believed that tanks can be a significant source of drinking water even in arid regions. The 2001 Australian Bureau of Statistics survey found that 83 per cent of households with rainwater tanks considered the volume of water supplied was sufficient for their needs (EnHealth, 2004).

The general public perception is that rainwater is safe to drink. In most areas of Australia, the risk of illness arising from consumption is low, providing it is visually clear, has little taste or smell and, importantly, the storage and collection of rainwater is via a well-maintained tank and roof catchment system (Enhealth, 2004).

Sydney's water challenge

Since it origin two hundred years ago, Sydney has drawn its supply of drinking water from a variety of sources. By the mid 1940s the dams that supplied Sydney's water could not maintain unrestricted supplies especially during the long hot summers. Restrictions on water use were a frequent occurrence at the time. The Municipal Water Supply & Drainage Board, predecessor of Sydney Water Corporation, investigated new sites to construct a dam to guarantee supplies into the future. The Government's decision to build the Warragamba Dam was based on the assumption that it would hold sufficient water making Sydney 'drought proof' (Troy, 2005). However, for the first time since the dam was constructed in 1960, Sydney is now realizing that it is not a 'drought proof' city. For the first time since constructing the Warragamba Dam, Sydneysiders have experienced water restrictions, which are now at level 3 and unlikely to be relaxed anytime soon. The drought has raised the issue of water consumption to the centre public debate in Sydney.

Troy (2005) presented three key reasons behind the inability of Sydney's water supply system to meet demand, being the growth in demand due to population, need to maintain environmental flows, and reduced runoff in the drinking water catchments due to climatic cycles or global climate change. The safe yield from the system now has been exceeded on a number of occasions and the New South Wales government has been seeking ways of reducing consumption or reshaping demand.

A positive outcome of the drought has been that it has created the right environment for Sydneysiders to take notice and become aware of the importance of water for our survival and its limited supply. Various mechanisms are being used to reduce the demand of mains drinking water. Conserving and recycling water throughout communities, gardens, homes and industry gives the next generation a fighting chance at a sustainable future.

Total Water Cycle Management at Kogarah

Kogarah Council is in the Sydney metropolitan area and is currently under the Level 3 water restrictions, as imposed by Sydney Water Corporation (Sydney's state owned water utility). As a proactive Council it embarked on finding a sustainable and practical approach to managing the water cycle to achieve real water savings. In 2003 Kogarah Council in partnership with Sydney Water and the Institute of Sustainable Future UTS, became the first council in Sydney to adopt Total Water Cycle Management (TWCM) principles into its Sustainability Management Plan, integrating these principles into on-ground projects at a catchment level in a planned and strategic approach. Three priority projects were identified for implementation in 2004/05:

- Beverley Park Water Reclamation Project,
- Rainwater Tanks in Schools Project, and
- Participation in Sydney Water's 'Every Drop Counts Program'

This paper will concentrate on The Rainwater Tanks in Schools project which assisted all 22 primary and secondary schools in the Kogarah LGA to increase the efficiency of water use and install rainwater tanks to reduce potable water use in toilet flushing and irrigating school gardens. The NSW Water Conservation Strategy states that water use should be consistent with the principles of ecologically sustainable development and water should not be used for a purpose where water of a lower quality could be used more efficiently and economically. By installing rainwater tanks in schoolyards, Kogarah Council has potentially saved thousands of litres of drinking water per annum, as rainwater is substituted for garden use and/or for toilet flushing.

The 'Rainwater Tanks in Schools Project'

The 'Rainwater Tank in Schools Project' focused on Ecologically Sustainable Development (ESD) objectives and employed best practice with benefits including cost savings, learning opportunities as well as the environmental benefits.
The aims of the project included:

- *Economic* – saving money on water bills, promoting the recognition of externalities, avoiding infrastructure development
- *Social* – considering policies and guidelines, building student capacity, promoting student ownership
- *Environmental* – promoting efficient resource use, promoting efficient water use, maintaining resource integrity, protecting environmental health

The project promotes a long-term Triple Bottom Line (TBL) investment strategy and is aligned with Kogarah Council's Total Water Cycle Management strategy. The project is also consistent with the objectives of Catchment and Waterways Program of Council, which seeks to reduce catchment impacts, by reducing the volume of stormwater run-off from urban areas and utilising stormwater as a valuable resource through innovative re-use strategies.

Project Methodology

Optimal rainwater tank size for each school was determined keeping in mind their water usage patterns as well as known constraints on the down-stream stormwater network in the vicinity of each school, using the continuous simulation model (Beecham, 2004). It is important to note that a continuous simulation model was used rather than a design-based model. Design-based models are commonly used in Australia and are often based around the determination of a suitable design rainfall intensity for a given average recurrence interval (ARI).

An alternative approach to the design storm is to use continuous simulation models that use actual measured rainfall data. These are widely used in Europe but Australia has been slow to adopt the approach. Because of the increased data requirements, these models are usually more computationally intensive (Beecham, 2004). The model can work at finer temporal resolutions by disaggregating daily rainfall data down to 6-minute time steps.

Given the diversity of student numbers, and other physical attributes such as roof areas and location of toilet blocks in 22 Kogarah schools, a number of assumptions were made for the purpose of carrying out the modelling exercise. According to Beecham (2004), these assumptions included:

- Roofwater is collected from a 100, 300 or 500 m^2 roof area, which drains via an integrated guttering and downpipe system to the installed tank. The roof draining to the rainwater tank was assumed to be 100, 300 or 500 m^2 in area because it predominantly covers all possible configurations. It is generally inefficient to harvest off roofs smaller than 100 m^2 in size, and it is rarely possible to direct more than 500 m^2 of roof area into a single tank (Beecham, 2004).

- Prior to entering the tank, roofwater is filtered primarily by leaf guards on all down pipes and then secondly by a first flush filter system installed at the tank inlet.
- Harvested roofwater is used to service toilet flushing. The same average rate of toilet use has been selected for all schools as that calculated from meter readings for Carlton School, i.e. 4.3 L/day/student.
- The model has been set up to only generate toilet usage rates during school days, with all holidays and weekends having a zero supply requirement.
- For periods of sustained rainfall, the rainwater tanks will reach ultimate capacity and commence overflow. The subsequent overflow volumes are added to the overall site discharge.
- Each tank is replenished with mains supply once the storage volume falls below one day's supply for the school's toilet flushing requirements. To adequately represent the range of schools in Kogarah, the model was rerun for usage rates corresponding to 200, 500 and 1000 students per school.

As highlighted in table below, the continuous simulation modelling undertaken for this study has shown that for roof areas between 100 and 500 m^2 and for school student populations ranging from 200 to 1000 students, tank sizes of 5 to 100 kL are required to provide 70% security of supply. However, in order to meet Sydney Water Corporation's guidelines for rainwater tanks rebate program, schools where rainwater tanks sizes of < 10kL were recommended, were however still given tanks >10KL.

Table 1 Required Tank Sizes to Achieve 50 and 70% Supply Security

Number of Students	Roof Area (m^2)	Tank Size to Achieve 50% Supply Security (kL)	Tank Size to Achieve 70% Supply Security (kL)
200	100	3	23
200	300	1	5
200	500	1	5
500	100	23	100
500	300	3	100
500	500	5	23
1000	100	100	100
1000	300	23	100
1000	500	10	100

Once appropriate tank sizes were determined for each school, Council officers undertook an analysis of the water consumption patterns of each school within the LGA. Sydney Water Corporation provided the necessary consumption data for this exercise. As per Sydney Water's rainwater tank grant requirements, this investigation was essential to classify which of the schools were currently and have historically met the Sydney Water's target of less than 15L/ student /day.

Schools that were meeting the target of 15L/student/day were selected in the first group to receive a rainwater tanks. As per the requirements of Sydney Water's grant scheme, those schools that were found to be having above target water consumption figures were selected to undertake a water audit. A School Principals forum was held at Council to disseminate information and to inform the schools on whether they were meeting the target. The principals were issued with fact sheets that explained the next steps in the process.

For the second group of schools with higher water consumption, water audits were also carried out and advice on reduction strategies was provided. Results from these audits were summarised by Council Officers and made available to the respective schools, in order to help them develop a Water Conservation Action Plan. Council assisted assigned school staff in the development of these Plans. Implementation of some selected actions from the Action Plan helped these schools in meeting the Sydney Water's demand target, and were subsequently issued with rainwater tanks.

Council staff with the experts from the University of Technology, Sydney also conducted site visits at all of the schools that were meeting the target. These visits were to identify potential sites for installation of the tanks, from where water could be used for toilet flushing as well as irrigation. Once these sites were confirmed with the relevant schools, Council engaged contractor carried out the installation. In addition to installation of rainwater tanks, a complementary water education program was also developed and is currently being implemented. Education program included carrying out water audits, tank decorating initiatives as well as the development of a Water Conservation Action Plan.

Project Outcomes
The major outcome of the project was the installation of Rainwater tanks in all 22 schools in the Kogarah Council area. The table below summarises the size of the tank and connections received by each school in the program. 20 of the 22 schools connected their rainwater tanks to toilets and the remaining schools used the water for irrigation purposes. This has maximised the reduction of potable water use for the majority of schools that participated in the project.

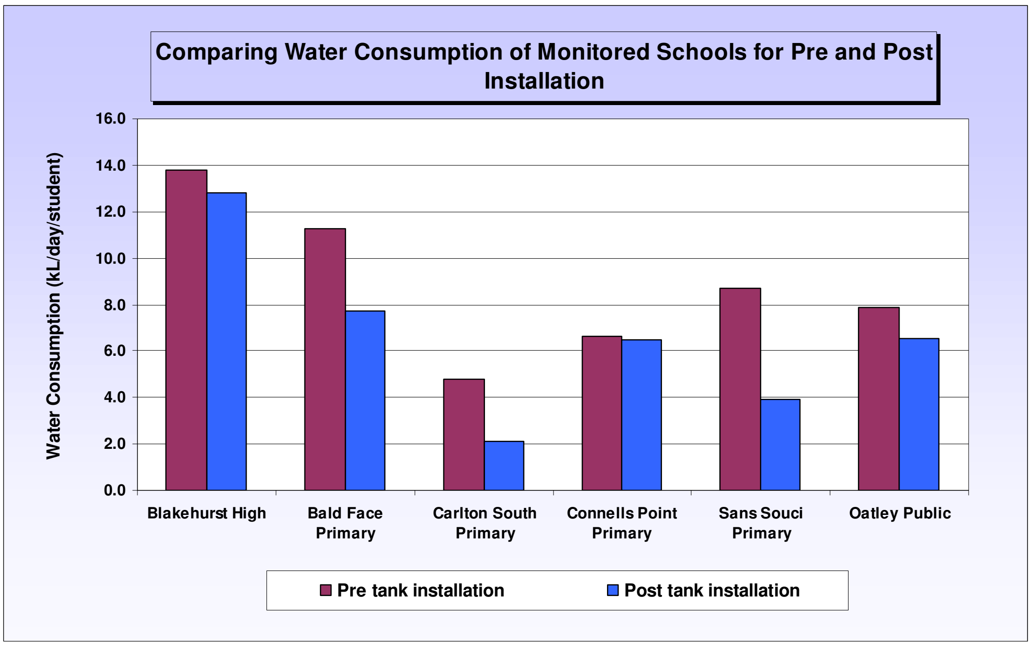

Figure 1 Water Consumption of Monitored Schools for Pre and Post Installation

Table 2 List of schools that received tanks

School	Size of Tank	Connection	Date of Installation
Bald Face Public School	13 500L	Toilets	Jan-05
Carlton South Public School	22 500L	Toilets	Feb-05
Kogarah Public School	10 000L	6 cubicles, 2 urinals	Feb-06
Hurstville South Public School	22 500L	Toilets	Mar-05
Mortdale Public School	10 000L	8 cubicles, 4 urinals	Feb-06
Sans Souci Public School	2 X 5 400L	Toilets	Jan-05
St George Christian School (Primary)	4 500L	Irrigation	Mar-05
St Patricks Primary School	10 000L	9 cubicles	Feb-06
Connells Point Public School	22 500L	Toilets	Jan-05
Hurstville Grove Infants	2 X 5 000L	7 cubicles	Mar-06
Mater Dei Primary School	10 000L	3 cubicles, 1 urinal	Feb-06
Oatley Public School	4 500L	Toilets	Mar-05
St Finbars School	4 500L	Irrigation	Mar-05
St Josephs School	2 X 5 000L	3 cubicles, 1 urinal	Feb-06
St Raphaels Primary School	10 000L	Toilets	Apr-05
Bethany College	4 X 2 500L	7 cubicles	Mar-06
St George Girls High School	2 X 4 500L	Toilets	Feb-05
Blakehurst High School	9 000L	Toilets	Jan-05
Kogarah High School	2 X 5 000L	3 cubicles, 2 urinals	Jan-06
Woniora Road Special School	2 X 5 000L	6 cubicles, 1 urinal	Feb-06
Georges River College - Oatley Seniors High	10 000L	Irrigation	Jan-06
Carinya Special School	10 000L	5 cubicles, 1 urinal	Jan-06

As a result of tank installation, potable water was reduced by 2.2L/student/day in the Kogarah Local Government Area (LGA). This equates to over 7,000 KL per year the equivalent of nearly three Olympic sized swimming pools.

The educational component of the project included water audits for the 11 schools that were identified as higher water consumers. The results of the water audits were made available to the schools and this showed that the majority of water used in schools is for flushing toilets, washing hands, drinking, cleaning and irrigation. Table

3 summarises the water audits conducted at all 11 schools and included suggestions for improvements.

Table 3 Summary of Water audits conducted at 11 schools

Toilets	Many of the schools audited still had single flush toilets installed. A normal single flush toilet can use up to 12 litres of water in one flush. Installation of new, more water-efficient toilets or a cistern converter was suggested to reduce the amount of water used to flush a toilet.
Taps	Tap aerators restrict the flow of water from a tap without reducing water pressure. Fitting an aerator to school taps will reduce the amount of water used by each tap by more than 50%.
Cleaning	Where possible staff were encouraged to sweep or to use a bucket to wash and rinse instead of running the taps or hose. A hose can use 20 litres of water per minute
Garden	Choose local native plant varieties and other water wise plants for less maintenance and watering. Install a drip system – This is the most beneficial and efficient method of watering plants. It places the water right where it's needed and at the rate the soil can absorb. It's also cheap and easy to install. Use good mulch – Mulches can prevent up to 73% evaporation loss and they are one of the cheapest and easiest ways to make the most of water in the garden. Water the roots, not the leaves – Watering leaves increases water loss through evaporation, and may even damage them. Sow drought tolerant lawn seed – A lawn can use more water than any other area in your garden. Sowing drought tolerant seeds such as Kikuyu, Couch Grass, Fescues, Native Grasses, Kentucky Blue-grass and Perennial Ryegrass will help save water.
Additional	Checking for leaks in taps is an easy way to reduce water wastage. One leaking tap can waste more than 2,000 litres a month. A leaking toilet can waste more than 16,000 litres of water in a year. To check for leaks put a little bit of food colouring in your toilet cistern. If without flushing, the colouring begins to appear in the bowl you should repair your toilet.

A flow on effect from the water audits was the energy and waste audits which were conducted at the same time. A school specific document was produced informing the schools on the most sustainable practices to better manage their assets.

The successful completion of the water audits and distribution of the results lead to development of a Water Conservation Action Plan for the school. The purpose of the Plans was to provide direction and actions for each school to become more water efficient. An example of a Water Conservation Action Plan in Table 4 sets targets for each school to reduce their potable water consumption and develop a sense of environmental custodianship.

Table 4 Example of the Water Conservation Action Plan developed

What is the problem?	How can we fix this problem?	Who will fix this problem?	When will we fix it?
Leaking taps and toilet cisterns	Put up signs in toilets to encourage students to report leaks. ------------------------ Regular checks on appliances	Assign a "water saver group" amongst students to be responsible for reporting any leaks. ----------------------------- Maintenance staff can perform regular checks on taps and toilets.	Immediate action should be taken. Ongoing action.
Students and Teachers unaware of water conservation	Talk at an Assembly informing everyone of the importance of the rainwater tank. ------------------------ Put up signage to remind everyone of the importance	Principals to assign a teacher or themselves to give a talk highlighting the water conservation issue, ----------------------------- Council to provide a sign for the rainwater tank.	Immediate action should be taken.
Getting complacent with water usage	Monitor the schools water consumption through the meter.	Principals or assigned staff can check the Sydney Water bills and monitor that water consumption is not increasing. A "water monitoring group" can check the meters ever month and work out consumption.	Immediate action should be taken. Ongoing action.
Reducing water usage further	Retrofit the schools water appliances. ------------------------ If possible connect the rainwater tank to more toilet blocks.	The principal or assigned staff can look into getting funding for replacing appliances with water efficient varieties. (Water Audits performed provide recommendations for saving water). ----------------------------- Contact the rainwater contractor for further options.	If/When the school gets funding for retrofitting or extending the rainwater capacity options.

Ongoing monitoring of the schools water consumption is carried out to assess the projected water savings with those actually achieved. This allows the staff and students to remain engaged in activities which encourage long-term behaviour change and sustainable water usage.

Project Challenges

To avoid any issues with tank placement, the principles of the schools should be present during the site selection process. Principles of the schools within Kogarah LGA were involved in the implementation of the project from the onset with an expression of interest sought, fact sheets produced and educational forums held.

To encourage ownership of the tank it is recommended that a key class become "tank watchers"; this would include meter monitoring and follow up actions outlined in the water audit plan. It is therefore important to have the resources available to brief the class on what is required in this regard.

Sydney Water also played an active role and was kept informed from the start. Whilst time consuming, this was the key to the success of the project and resulted in a financial contribution of one third of the cost of the project.

Lastly, it is also important to have the sufficient resources in place to be able to carry out the project successfully. Resource is required to ensure that schools follow up on the progress of meeting their demand target and execute their water conservation plans. It is important that the schools are also given support and help throughout the process.

Project Achievements

The Rainwater Tank in Schools Project utilised and promoted the effective and efficient use of drinking water by meeting the irrigation/toilet flushing needs of schools with non-potable water, without adding any cost burden to the community. From the monitored water consumption of 6 public schools, the project brought approximately 0.1 L/student/day to 4.8 L/student/day with an average savings of 2.2 L/student/day. In addition, by using non-potable water for irrigation and toilet flushing, the program has decreased the load on all waters infrastructure (potable, wastewater and stormwater) and added to an increased life cycle. The project also resulted in a decrease of stormwater run-off, resulting in a decrease in pollutant load conveyed by the stormwater runoff, as well as reducing the load on the stormwater system.

Water audits completed by the high water user schools ensured water demand targets were met and employed water conservation principles as part of their Environmental Education Policy. This encouraged water conservation behaviour amongst, not only the students, but the teachers and staff at the schools too. Prior to installation of the tanks, the Schools made a commitment to the management of the school resources and grounds, as well as introducing environmental education into the curriculum resulting in numerous learning opportunities as well as the environmental benefits.

Signage was a large component of the education program with signs erected at all schools near the tank and in some circumstances at the front of the school whereby parent, visitors and students are constantly reminded of the water conservation message. This also serves as a constant visual representation of the school's and students' efforts.

Following the tanks installation a survey was carried out with all the participating schools assessing the effectiveness of the project, and results are summarised below.

The main benefits in participating in the program.

38%	Contribute towards water savings and conserving water
34%	Educate students on sustainable water use
20%	Save money by reducing water bills
8%	Create less pollution in local waterways

Has participation in the program increased the appreciation of water conservation amongst students.

71%	Yes
10%	No (Kindergartens and Infants found educational component too hard to convey to their students)
19%	Maybe (Some schools didn't undertaken any monitoring of message uptake)

What everyday behaviour has change from the students.

46%	Increased awareness of current drought and water restrictions
42%	Willing participation in education programs
12%	Less incident of taps left running

The totaling environmental education package gave each school the necessary tools and awareness to acquire the new sustainable rainwater tank assets and reap the rewards both physical and educational for future generations of students. Through capacity building, the students were encouraged to take ownership of the rainwater tank and all that it represents.

The education component improved knowledge, attitudes and behavior of the students and teachers in the schools and facilitated the shift towards achieving sustainability. The empowered students have become custodians of their local ecosystem and the water conservation message will have a filter effect on local families.

Conclusion

The schools rainwater tanks have reduced the amount of drinking water used for toilet flushing and/or irrigation. By installing rainwater tanks, schools reduced their potable water usage by 3 litres/day/student in the Kogarah LGA, which amounts to a total of around 7,000KL/per annum.

The rainwater tanks also act as a visual reminder to conserve water for the students. The project has equipped the next generation with the necessary tools to make informed decisions and undertake actions that will move towards achieving sustainability. The program has also given student ownership to the program and environmental knowledge and learning, which is central to sustainable decision-making.

Water.
Clear water, fresh water, salt water,
Earths water. My water.
By Eleni Dirnitriadis (Year 4, St Raphael's Primary School, 2005)

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