Michael K. McCall
ITC, University of Twente,
Enschede, the Netherlands and CIGA, UNAM
Morelia, Mexico

Abstract
Mapping children’s views of place and their concepts of space, and interpreting their mental maps have been addressed for a variety of purposes and from a variety of standpoints, from child psychology, pedagogy, environmental geography, health and safety management, and urban planning. This is a short overview of many of these investigations.

Initially, the demand was seen just in terms of training and practice exercises for children, in drawing techniques and in geographical and navigation skills. But geographers and child psychologists developed new approaches to conceptualising, representing, and transferring cognitive spatial concepts from a child’s mind. Jim Blaut was a pioneer in theoretical and conceptual discussions about how children perceive space and distance, contiguity, proximity, how they symbolise spaces and places, and how they ascribe values to locations (Blaut 1991; 1997); Blaut et al. (1970a, 1970b). Others researchers in a similar frame are Catling (1979), Golledge et al. (1992), and Matthews, H. (1984, 1987). These studies were mostly in the US and UK, though al-Zoabi (2001) worked in Jordan; Matthews, H. (1995) in Kenya, and Kwan (1998, 1999) investigated pre-teenage children’s vernacular perception and experience of maps in Hong Kong. Blades et al. (1998) made cross-cultural studies of abilities of four year old children in air photo reading, map reading and navigation in South Africa, Iran, and Mexico City.

These studies mostly draw upon the classic work of Jean Piaget, epistemologist and godfather of cognitive development studies of children. Children follow developmental stages, first living in magical thinking, then mastering concrete operations involving spatial dimensions, and later developing cognitive constructs of space. Piaget’s stage constructs related the Child’s Conception of Space (Piaget and Inhelder 1956) to the development of children’s conceptions of topology, time, numbers, causality, and morality.

Participatory mapping and PGIS, with children, however, are also utilised to elicit children’s special knowledge about a range of topics: how children perceive, respond to, and interact with the environment and natural resources, children’s perception of hazards, and what children feel about security, the potentials of places and spaces for protection and play. There are few studies outside of North America or Europe, but numbers are growing.

Participatory methods
Children utilise a variety of inscribing (e.g. drawings) and incorporative (e.g. displays) means to represent space and sense of place, with many differences from adults. Drawing mental maps and making physical models can be seen with any group of children, and research into how children make their own maps or work with extant maps is well developed. Eg. Peterson and Saarinen (1986) related symbols to the sense of place. David Sobel’s Mapmaking with Children (1988; and 1998) aimed at elementary children, is a clear exposition and justification for encouraging children to acquire appropriate mapping skills.
More recent are studies of how children understand and learn from images, how they develop cognitive maps of environments through photographs (Wong & Gerber 1999; Dennis 2006), or work with anaglyphs and aerial photos (Stea & Blaut 1973; Plester et al. 2002, 2003). There are few studies linking children with P3DM (participatory 3-dimensional modelling) (Rambaldi et al.) despite the obvious love of children for modelling in plasticine, mud or any plastic media.

More advanced spatial technologies are developed for children to use in PGIS applications, especially in environment and safety in urban community planning. There are positive experiences with training even young children to use GPS and mobile GIS with PDAs for mapping their significant neighbourhood and spatial elements (e.g. Frost 2004). This approach is encouraged in North America by the Orton Family Foundation and Common Ground community mapping project. Orton supports children’s mapping in e.g. Argentina. The Green Map system is a PGIS means for locally-driven exploration in urban areas, initially in the USA (Tulloch 2004) and now in over 50 countries, many in the South. The focus is on mapping community’s perceptions and values of their local environment, and many maps are being made by children (www.greenmap.org; http://www.greenmap.org/ymaps/ymindex.html)

In India, CSDMS has instigated P-mapping and PGIS by school children (Gupta et al. 2003). In the Nepal terai, children’s knowledge of adaptation to climate change, especially flood hazards, has been investigated with participatory video methodology for disaster preparedness (Plush 2009).

Of course the advent of Google Earth, with its high creativity and flexibility, has greatly accelerated this trend. Children around the world are playing with and inventing new uses for Google Earth and other virtual globe images faster than academic researchers can keep up with them.

**Children’s views of environment**

A series of innovative, radical participatory planning exercises were carried out in the US and Canada in the 1970s by William Bunge and his associates, the Society for Human Exploration, Detroit Geographical Expedition, and Canadian Alternative. The mapped items and map legends of Geography of the Children of Detroit (SHE, 1971) include automobiles, trucks, dogs, cats, green and dead shrubs and trees, bicycles, rubbish, trash, broken bottles, cans etc. Taylor (SHE 1971) viewed spaces in Detroit from a child’s point of view, whilst Bunge’s (1969) Atlas of Love and Hate mapped areas friendly to children and areas hostile to children. More recently Dennis (2006) applied qualitative GIS in Madison, WI with photos, drawings, narrative, and participatory mapping of youths’ social environment. (cf. Halseth & Dodridge 2000; MacDonald-Carlson 2003 in Canada; and Matthews, H. et al. 1998, 2000 in rural and urban UK). Mathews, S et al. (2005) employed space-time mapping with children and variability on disability and ethnicity - geo-ethnography - in the USA. In the first generation of mental mapping was a perception study of residential desirability by children in western Nigeria and Lagos. (Gould & Ola 1970); Peter Gould with Rodney White is better known for mental maps and spatial perception studies in the UK and USA, many from school children or school leavers (Gould & White 1968, 1969, 1995).
For practical reasons owing to accessibility, interest and pedagogical priorities, the majority of applications have been in urban settings, and usually the sources have been school children in their schools.

Children's pictures to children's maps
Children's interests and priorities, and needs and problems can be shown as rich pictorial representations. Anderson et al. (2005) and Bandrova et al. (2009) provide impressive and emotional collections of mental maps from the Barbara Petchenik Children's World Maps; the horse world is a beautiful example. The books do not interpret the origins or cognitive processes embodied in the children's maps, but they provide excellent raw material for analysing children's visualisation.

The methodological question is, can those mental maps be transformed into maps showing spatial information? The initial step is that children make and show pictures of good / bad, or nice/ nasty, or safe / dangerous environments, simply as pictures which are then talked about, individually and in groups to get better understanding and interpretation by the researcher (cf. Maneja et al. 2009).

The subsequent step is that the environmental issues (both positive and negative) have to be associated with specific locations or general zones. This is in order to progress towards a better understanding of the child's perspective on environmental issues, but there is also a functional planning purpose towards amelioration and mitigation of the environmental problems.

The children, and their parents and teachers, can then be involved not only in identifying the problems, but also in analysing them, that is recognising their causes and their interactions, and coming up with ideas for solving the problems. Participatory planning means that the local actors think of solutions as well as being asked to identify the problems.

Many of the items that the children draw are specific places, e.g. dangerous sites, dirty water, pollution, play areas, etc. In spatial terms they will be point data or line data or areas (zones). Therefore, some of the preferences and problems can be easily located in space in absolute locations. Whilst drawing the picture, the children could be asked to say where the environmental issues or items are to be found - Mark the good/bad places on a map or an aerial photo, or make a sketch map, or simply asked for the names of the places.

Maybe they are not absolute locations, but the relative location of the places, relative to each other, or to the subject, is the person making the drawings. Many of the issues will be multi-locational; e.g. dangerous roads, dirty streets, pollution, sports facilities and playgrounds, etc. Then the mapping can use a conventional legend. Maybe the researcher has to investigate and interpolate to find out where these sites are. A few issues however will be locationally non-specific, e.g. ambient climate conditions or bad weather, or an ambiguous feeling towards teachers or authority figures. There is not much point in trying to
Urban children worked with PGIS to map their local environmental places and routes, traffic safety and security, in Stockholm and central Swedish villages (Berglund 2008), Berglund and Nordin (2005, 2007). This is used as a communication tool for children, teachers and planners. With little assistance, 10- to 12-year-olds, and 15 year-olds mapped their routes, special places, marked activities, and wrote narrative comments. Teachers also mapped routes and places, and the results have proved reliable and accessible by planners, thus facilitating children's influence on spatial planning. Something similar is found from Finnish children's participatory GIS of the quality of their living environment. Children identified their own neighbourhoods, houses and schools, and indicated how they spent free time, and what they considered safe or dangerous places (Kytta 2007).

In Jordan, we find Al-Zoabi's (2001) study of children's cognitive maps in urban neighbourhoods, showing differences between boys and girls and social factors. In Mexico, children rendered visualisations of pleasant and dangerous environments and the determining factors, including some interpretable as spatial components (Maneja et al. 2009). Matthews, H. (1995) mapped Kenyan children's views of place, the environmental experience and awareness in the culture of young Kenyans; and geographies of childhood were made by Kampala street children (Young & Barrett 2001).

Leading the way in India was CSDMS (Centre for Science, Development and Media Studies) which instigated participatory mapping and PGIS by school children (http://www.neighbourhood-mapping.org/GramChitra.htm) in urban neighbourhoods and villages, eg. local environmental mapping by children in Uttaranchal State (Gupta et al 2003; Mallick & Kalra 2005; Mallick et al. 2005); and village mapping and drinking water conditions in a Delhi community (Mathur et al. 2001).

**Spaces of health, safety and violence**

Safety and security issues are important elements of the child's environment, vulnerable because of their physical and emotional immaturities. Adult planners and policy-makers are taking these dangers more seriously, driven by parents' and teachers' concerns. The Swedish and Finnish policy-directed studies above (e.g. Kytta 2007) are typical examples of this, where through participation and PGIS, the children assess the hazards in their living environments. Children's consider safe or dangerous places, and how they make use of their environment.

In Madison, Dennis (2006) utilised PGIS, photos, drawings, narrative, and participatory mapping of the social environment of youth as an input to urban planning. In Kampala, street children made their own maps and applied visual 'action' methods to communicate their safety situations in the socio-spatial environment; and in Guatemala City participatory maps made by young people and youth gangs recognised security and violence issues arising from their spatial mobility (Winton 2005). Children's experiences and knowledge of natural disaster risks using local knowledge and PGIS have been researched in Nepal (Plush 2009), and in urban Venezuela (Munoz, 2007).

Health-related children's physical activities, or lack of them, were studied using mental maps,

A vital concern is children’s safety in the journey to and from school, with traffic dangers and other hazards. In the US, a Safe Routes to School program elicits mental maps of children’s experiences of accessing school by bicycle or walking, e.g. in San Francisco Bay (Appleyard 2005), and children’s street liveability for children. Osborne (2005) reviewed safe and healthy routes (i.e. counteracting child obesity) for cycling and walking to school in Denmark, USA and UK, though it did not explicitly use GIS; and the Swedish studies of Berglund (above) included children’s perspectives on traffic safety. The Neighbourhood Road Safety Initiative in UK mapped children’s walk to school in Liverpool. Hull and Molyneux (2005); and Wurtele and Ritchie (2005) integrated healthy travel for youths and children into municipal transportation planning.

Associated with security perceptions are the therapeutic benefits of children drawing pictures to deal with trauma in their lives, whether from domestic abuse, urban violence, or external disasters of floods, earthquakes, tsunamis, fires, etc. Drawing maps of spaces familiar and maybe friendly to them is an extension of drawing pictures of the traumatic events and the places where they happened, Clacherty (2006) combined trauma therapy with art, though not maps for refugee children in South Africa, her world in a suitcase: psychosocial support using artwork and McCall (2005) showed how children can make mental maps of their former neighbourhood spaces and lost homes in post-disaster situations, e.g. after the 2004 tsunami.

Conclusions where next?
The intention of this review is to stimulate more geographers to research into children’s PGIS, and to stimulate planners to take children’s local spatial knowledge more seriously.

With respect to methods, children take up new digital technologies with so much more abandon than adults; this applies equally to GPS, mobile GIS, geotagging, Google Earth mashups, and innovative geospatial tools. Social planners need not be concerned about children’s capacities to handle and add functionalities. Existing research into video games and virtual realities like Second Life could extend further into how children participate in spatial activities.

Conceptually, it is important to understand children’s behaviour in space and their experiences and interpretations. Differences between children and adults in spatial cognition are psycho-developmental, children’s cognitive procedures progress slowly, maybe in steps. But the differences are also social and behavioural. Children’s behaviour in space is framed by their physical and mental capacities and by permissions and limitations which are different from those of adults where they go, when they go, and what they do wherever they are.

Mapping with children therefore is essential for better practice in planning of children’s time-space, especially in urban situations. And beyond this, children’s specialised local knowledge may be vital for better practice in management of adult spaces, as in gaining new perspectives into environmental dangers and hazards.