WATER MANAGEMENT CHALLENGES IN THE NETHERLANDS

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INTRODUCTION: THE ONGOING BATTLE

For generations, Dutch elementary schools taught their pupils that the creation of the Netherlands was determined by four factors: sea, rivers, land and, last but not least, man. Pupils learned to be proud of their ancestors because of their successes in conquering land from the water. A more detailed view reveals, however, that many battles with the water were lost because of human behaviour (De Haan and Haagsma 1984). Nevertheless, the victories of the past century are impressive. They include the closing off of the former South Sea (Zuiderzee) by means of a 30 kilometre long enclosure dam, 145,000 hectares of new land created by means of land reclamations in the geographic heart of the country and the large-scale, multi-dimensional and multi-purpose "Delta Works" in the Southwest, improving the overall safety of that region.

In this year's series of "The Netherlands in Maps", we have presented a few of the many dimensions of the fascinating topic of Dutch water management:

- Land reclamations and floodings (Map 2004/1)
- Water board taxes (Map 2004/2)
- Water quality (Map 2004/3)
- Acidification and desiccation (Map 2004/4)
- Water board expenditures (Map 2004/5)

We have deliberately put some emphasis, as far as possible, on the financial dimension, because the war between water and land – or more appropriate: between water and man – is far from over. In our introductory article to this year's series of maps, three interrelated future threats have been identified (Van Steen and Pellenbarg 2004, CW 2000, Kors 2001). First, the rising sea level, necessitating the heightening of sea dikes. Second, a drop in the level of land, especially in the peatlands of the coastal zones of the North Sea and the Wadden Sea. Third, changing seasonal precipitation levels, causing a rise in the winter levels and a drop in the summer levels of the major rivers. Large sums of money are needed in order to timely deal with these issues.

In this article, we will first present an overview of the history of floodings and attempts to control the water. Subsequently we examine the position of the water board, a key actor in water management issues on a regional level. Attention is then focused on the topic of water quality. Finally, the financial challenges of future water management in the Netherlands are discussed.

THE WAR ON WATER 800-1900

As is illustrated by Map 2004/1 the Netherlands is clamped in between the North Sea on the one hand and major rivers flowing into the country from other European countries. The Scheldt and the Meuse rivers enter the Netherlands from the South, delivering huge amounts of water from catchment areas in Belgium and France. The Rhine river enters the country in the East and flows partly to the North Sea and partly to the former South Sea, now IJsselmeer, and Wadden Sea in the North. The Rhine river has an extensive catchment area of over half of Germany as well as smaller areas in France, Switzerland, Luxembourg and Austria. Large amounts of European water thus move through the Netherlands to the sea. These water masses are tapped off for drinking water and irrigation purposes, supplemented by domestically produced rainwater and – cleaned – wastewater. The main rivers and connecting channels are also used for international freight transportation by boats.

On top of this, almost one fourth of the country is situated below sea level (Meijer 1997). The lowest part of the country can be found in the municipality of Nieuwerkerk aan de IJssel (located along the river Hollandse IJssel), just north of Rotterdam, at 6.7 metres below sea level (Van de Ven 2003). Historically, the lands now lying below sea level have either been conquered from the sea or they have resulted from the complete or partial draining of inland lakes (Kranenburg 2001). In both cases, dikes have been the crucial factor in keeping out the unwanted water.

The first dikes appeared in the Dutch landscape over 2,000 years ago (although the Romans were probably the first to construct dike-like structures in an attempt to protect lands from water). In those times, the sea level was approximately 1.5 metres lower than present. The gradual rising of the sea level in the subsequent centuries only partially explains why dike construction along the sea, along rivers and around lakes was an ongoing process of defeat (when low dikes broke or collapsed, or were overtaken by the water) and success. Another important reason for an increasing amount of floodings and dike breaks was human behaviour. In the centuries following 800 A.C., the Dutch residents actively started changing and exploiting the land (Van de Ven 2003). In peat areas in the Western and Northern parts of the country, artificial water drainages were installed and the land started to descend because the natural process of peat formation stopped. Lower lying areas became more and more vulnerable for floodings. Whenever these floodings occurred and sand was deposited on the peat, the land surface would decline more and the inland water masses would grow in size. Peat was also used as fuel and for the extraction of the coveted salt in the coastal areas (Kranenburg 2001).

Between 800 and 1250, the Northern and Southwestern Netherlands lost large amounts of land to the sea (Van de Ven 2003). In the same period, inland lakes in the peat areas were expanded because of the extraction of peat. Although human behaviour was the principle factor for this loss of land, occasional storm tides accelerated the process. Seven large storm tides between 1134 and 1248 enlarged sea arms and river estuaries. The Netherlands had changed from a country with a more or less closed coastline in 800 to an area that was now under direct, vulnerable influence from the sea. Also, the course of the main rivers changed gradually, partially because many smaller interconnected water streams were closed off or channelled. It should be noted that high river waters and river floodings on river plains originally were seen as natural events, not as problems or disasters.

Between 1250 and 1600 the coastline of the Netherlands changed again and again (Van de Ven 2003). More and more storm tides caused the dikes that had been constructed in the previous centuries to break, and the areas that were consequently (temporarily) flooded became larger and larger. The waters of the South Sea, which had been formed in the previous centuries, repeatedly spilled over onto the adjacent lands.

Until the seventeenth century, the struggle against water by the residents of the low-lying parts of the Netherlands was purely defensive (Kranenburg 2001). Whenever a dike broke, a new dike would be constructed; sometimes, as was the case along deep waters, as an emergency dike behind an existing weak dike. Agricultural land, farms and houses in the area between the two dikes would be abandoned. More often than not, a lack of coordination caused dike repairs to be postponed, allowing subsequent floodings to increase the damage already done. Repeatedly complete villages were taken over by the sea or by changing river courses (Van de Ven 2003).

Technical improvements in dike construction and water drainage techniques gradually introduced a more offensive attitude towards water. Land reclamations came underway, stimulated by the growing need for agricultural land due to the population increase, an economic growth which released the necessary funds for the reclamation projects, the entrepreneurial spirit of Amsterdam merchants and, last but not least, a growing fear for new floodings (Kranenburg 2001). Already at the end of the eighteenth century, large amounts of water had been reconquered and transformed into productive agricultural lands. After centuries of primarily man-caused loss, the war between water and the Dutch turned into a victory for the latter. This was not to say that land was no longer lost. An example is the island of Schokland in the South Sea (Van de Ven 2003). This island was protected by a system of low dikes. Very gradually, more and more land was lost to the sea, notwithstanding desperate defensive attempts by the residents of Schokland. In 1859, the national government decided to abandon the island despite the fact that the inhabitants themselves wanted to stay. When the Northeastpolder was reclaimed in 1942, the island resurfaced. In 1995, UNESCO placed the island of Schokland with it's restored church and a few houses on the World Heritage List as a symbol of the ongoing Dutch struggle against the water. It was the first Dutch monument to be included on the World Heritage List.

The land reclamations, inland when lakes were drained or along the coastline when shallow lands were diked, resulted in polders: areas surrounded by dikes with groundwater level control, usually by means of pumping stations. The introduction of steam power in the second half of the 19th century enabled a more precise control of the groundwater level between 0.5 and 1 metre below the ground surface, making the land suitable for agriculture. Later, diesel and electric pumping stations even allowed for the groundwater in the polders to be controlled at a level of more than 1 metre below ground surface, thus enabling the growing of crops (Kranenburg 2001). The Netherlands now has 5,000 polders. Many, but not all, lie below sea level.

WATER CONTROL WORKS 1900-2000

In the twentieth century, three important water management projects were installed in the Netherlands (cf. Van Steen & Pellenbarg 2004).

The first is the so-called Zuiderzee project (South Sea project). In 1891, engineer Lely, who eventually became Minister, proposed to construct a 30-kilometre dam between the provinces of North Holland and Friesland. In this way, the inland South Sea would be transformed into a lake (IJsselmeer). His plan also included the construction of a number of polders (Kranenburg 2001). Implementation of the plan in 1920 was stimulated by a serious flooding a few years earlier, as well as the World War I experience that the Netherlands had become too dependent upon other countries for it's food. The new polders would bring the necessary expansion of agricultural land and domestic food production. The enclosure dam was finished in 1932, just two years after the completion of the Wieringermeerpolder in the Northeast part of North Holland. The latter polder served as a learning device for the construction of the remaining three polders: Northeastpolder (48,000 hectares, completed in 1942), Eastern Flevoland (54,000 hectares, 1957) and Southern Flevoland (43,000 hectares, 1968).

A second important and impressive project was the Delta Project, an interrelated set of works aimed at protecting the Southwestern part of the Netherlands, both from flooding as well from the negative impacts of salt water. Following many decades of plan development and research, a commission already in 1940 concluded that the quality of the dikes in large parts of the province of Zeeland was alarming. Subsequent studies revealed that dikes in other provinces also were in a bad shape. On January 29, 1953, two different detailed plans for a partial closure of the sea arms in the island and peninsula region were presented. Two days later, due to the combination of a severe storm and high tide, large areas of the province of Zeeland were flooded, killing over 1,800 people. The implementation of the Delta Project was speeded up, and in 1997 the last in a series of dams, sluices and dike enforcement was completed. The completion of the Delta Project has greatly enhanced the safety in the whole region. Also, it has strongly weakened the geographic and economic isolation of the area, as well as introduced recreational opportunities (De Haan & Haagsma 1984, Van de Ven 2003, Kranenburg 2001).

A third and final large water management project was labelled "Delta Project of the Large Rivers". In the 1990s, a series of smaller floodings occurred or threatened to occur along the major rivers entering the Netherlands from Belgium and Germany. The threats of late 1993 and early 1995 led to proposals to strengthen and raise the levels of extensive tracks of river dikes (cf. Driessen & De Gier 1999). Related to this project is the recent proposal to create three emergency overspill areas alongside rivers in the Eastern part of the country, that could be used to store large amounts of river water from the Rhine and Meuse rivers in case of extreme high river water levels (cf. Van Steen & Pellenbarg 2004). These overspill areas, which are indicated on Map 2004/1, are Rijnstrangen, Ooijpolder and Beersche Overlaat.

In the past eight centuries, the Netherlands has lost about 570,000 hectares of land to the sea. In the same period, 520,000 hectares of land was reclaimed, resulting in a net loss of 50,000 hectares compared to the situation in 1200 A.C. (Van Duin 1987). The end balance could have been close to zero, if the plans to also reclaim the "Markerwaard" as the final polder of the South Sea project had not been abandoned in 1991. The reclamation of this part of the IJsselmeer, situated nearby Amsterdam and Almere, was no longer seen necessary due to the decreasing population growth, environmental concerns and a reduced need for additional agricultural land (Kranenburg 2001).

WATERBOARDS

Historically, the control and management of water was organized locally. Already in the 12th century, local, loosely organized organisations developed, that aimed at maintaining the water level of the lands in their boroughs and hamlets. The duties of the local land owners could take various forms. For example, they could be responsible for the maintenance and protection of a small part of a dike which would need to be carried out personally. Later on, inhabitants were charged fees and dike repairs and water control was carried out by the water organizations.

In the 13th century, the present-day 'waterboards' developed as the first democratic authorities in the Netherlands. Local organizations with public participation in the management boards were created. These 'water boards' were established on an ad-hoc basis, for example following a flooding or an other water management problem. When a new problem occurred, a new cooperation might be created, sometimes overlapping the territory of existing water boards (UvW 2004). Huisman (2002) comments that inhabitants themselves essentially created the water boards, on the basis of the 'interest-taxation-representation' triplet. The amount of benefits that somebody derived from the activities of the waterboard would define the amount of tax contributed to the waterboard as well as the degree of participation in that waterboard. In the words of Huisman: "democracy in the Netherlands is waterproof".

In the 19th century, a decision was made to coordinate and reorganize the thousands and thousands of local water boards. Provinces controlled and coordinated the local water boards. Many water board mergers took place. The number of water boards gradually reduced from 3,500 in 1850 to 2,500 in 1950 and, in the context of the Delta Project, eventually to 48 water boards in 2003. A further reduction to 25 or 26 water boards in the near future is foreseen.

Nowadays, water boards are decentralised public authorities with legal tasks and a self-supporting financial system. Members of the water board are elected once every four years. In this respect, they operate as a level of public governance, which is unique in the world (Smit 2004). The historical task of flood control has been broadened and the tasks of water boards are now more closely related to and integrated with land use planning, nature conservation and environmental protection. Four separate tasks can be distinguished (UvW 2004):

- Water control: the provision of protection against sea and river water by means of dunes, dikes and canals. Protection may ask for embankment and fortification of dikes. A related task is pest control of the muskrat in order to protect the dike structures.
- Water quantity: managing the amount of water and ensuring that it is kept at the right level. A water board typically manages an extensive system of streams, canals, ditches and trenches. Pumping stations, dams and sluices work to control the level of surface water. In natural areas, water retention aims at preventing land from drying out. On the other hand, lower water levels are necessary for crop growth.
- Water quality, including waste water purification of houses, protection of industrial pollutants in the water system and, in general terms, reduction of various sources of pollution (e.g., flushing away of manure and pesticides from agriculture).
- Management of inland waterways and roads: rural road maintenance, depth maintenance of watercourses.

Not all water boards carry out all of these four tasks. For example, of the 37 water boards existing mid-2004, 12 water boards are not responsible for the water quality in their area (UvW 2004). This is a first indication that water management in The Netherlands is still the responsibility of many authorities. The organization of water management responsibilities has been characterized as "chaotic" (Smit 2004), because in each region or subregion the water control tasks are shared between different authorities, often in different ways. The water boards operate in a complex arena of national, regional and local entities, including:

- The national Ministry of Transport, Public Works and Water Management, responsible for groundwater level control, flood control and purification of wastewater;
- The national Ministry of Spatial Planning, Housing and the Environment, responsible for the drinking water and sewer systems;
- The national Ministry of Agriculture, Nature and Food Quality, responsible for the so-called "wet" nature;
- The twelve provinces are each responsible for policies affecting the surface water as well as the ground water in their area; they also manage the ground water.
- The various departments of 'Rijkswaterstaat' are responsible for the main (supra-regional) watercourses, as well as flood control, water quantity and water quality. Also, this sub organization of the national Ministry of Transport, Public Works and Water Management coordinates the national water policy.
- The 483 municipalities, who control the sewer systems in their cities and towns.

- The waterworks companies, who extract, produce and distribute drinking water.

As the illustration accompanying Map 2004/2 revealed, the larger share of the water board expenditures is in the field of water quality measurements. In 2003, all water boards together spent 61% of their budget on water quality. Another 29% was used for water quantity measures. Water or flood control claimed 6.5% of the budget of the water boards, and the maintenance of inland roads and waterways only 2.5%. The latter is a task that only a number of water boards execute. Total expenditures by water boards amounted to € 1,800 million in 2003, which is about 20% of all, very broadly defined expenditures made in the Netherlands for water control measures (CIW 2000) and about 50% of all public water management expenditure. The distinguishing factor between the water board budgets and the expenditures made by other responsible authorities is the fact that water boards raise fees and taxes directly from the residents and firms located in the water board region. These fees and taxes are not uniform throughout the country, as was illustrated by Map 2004/2 of this year's series of maps. The regional variation in water board tax levels reflects the regional variations in the amount and expenses of water control works. These regional variations are visualized in Map 2004/5 included in this issue of TESG. Obviously, expenditures for flood control are higher in coastal regions and in lower lying parts of the Netherlands.

WATER QUALITY

In the past decades, the absolute and relative dominance of flood control in Dutch water management has gradually diminished to be replaced by a major attention to the field of water quality. The fact that over 60% of the budget of water boards is used for water quality measurements, as was mentioned above, illustrates this. Despite the impressive investments aimed at improving water quality, the – perhaps too ambitious – targets have not been met yet, nor will they be met within the next 10 years. Compared to the other components of water management in the Netherlands – e.g., flood control, water level control – the quality of water is presently the weak link in the water management chain (CIW 2004).

In the 'Vierde Nota Waterhuishouding' (Fourth Report on Water Management), published in 1998/1999, Dutch government has formulated targets for the amount of chemical substances in surface water. For each type of chemical substance, so-called maximum permissible risk levels as well as 'ideal' target levels have been established. For nitrogen, for example, the maximum permissible risk level (MPR) is 2.2 mg per litre and the target level is 1 mg per litre.

In Map 2004/3 the water quality performance of each water board region is expressed as a reference to the maximum permissible level of four chemical substances: copper, zinc, nitrogen and phosphorus. The map clearly demonstrated that a majority of the water boards still have levels of copper, nitrogen and phosphorus far above the calculated MPR's (and even further away from the ideal aspiration levels). Only six waterboards, most of them in the southern part of the Netherlands, have zinc levels exceeding the MPR level; one of these, located close to the industrial Antwerp harbour area in Belgium, has a zinc level exceeding the MPR level twice. Unfortunately, the situation for the other three chemical substances visualized in Map 2004/3 is much worse. Only two water board regions have a copper level in their surface water lower than the MPR. A closer examination of the map reveals that, for the four chemicals considered, the surface waters in the border regions in the South and Southeast have the highest degree of contamination.

Improvement of the surface water quality is easier said than done. The most important polluters are the agricultural sector and the neighbouring countries. The Rhine, Meuse and Scheldt rivers, entering the country in the South and the Southeast, transport large amounts of chemicals to the Netherlands. In the past 15 years, these quantities have remained at more or less the same levels (CW 2004). It can be concluded that the targets, set for the year 2015, will in many cases not be met. The ecological quality of the surface water in the Netherlands will also not meet the targets of the European Union.

A related topic included in this year's series of Maps is acidification (Map 2004/4). Acidification is the result of the presence and working of a number of chemical substances, including nitrogen. The objective for acid deposition is 2,150 acid equivalents per hectare in the year 2010. As the top map in issue 2004/4 indicated, large parts of the Netherlands have deposition rates which are higher. The Eastern/Southeastern regions in particular have high degrees of acid deposition. Acidification in the Netherlands originates from agriculture (43%), transport (29%), industry (10%) and a range of other, smaller sources (18%) (Roos et al. 2000). Roughly half of the acid deposition in the Netherlands originates in neighbouring countries. Since 1980, the total amount of acid deposition has dropped with 43%, largely due to a drop of sulphur emissions with 80%.

WATER QUANTITY

A very important issue in the Netherlands is ensuring that the right amount of water is available at the right moment. This is referred to as "water quantity": the prevention of floodings as well as the prevention of water shortages. Next to the century long battle to prevent lands from flooding from high sea or river water levels, recent decades have witnessed an increasing concern for the negative effects of drops in water tables. There are many dimensions to the topic of water shortages: the temporary shortage of water in itself but also more permanent desiccation, as well as changes in ground water flows and a different chemical composition of ground water whenever water shortages are solved by allowing water from elsewhere to flow into the areas or polders with water deficits (Roos et al. 2000).

Large parts of the Netherlands are vulnerable for desiccation. This is illustrated by the second part of Map 2004/4. In the provinces of North Holland (home to the city of Amsterdam) and Utrecht, 20 to 40% of land area has been classified as desiccated. Desiccation levels of 10 to 20% occur in 5 of the remaining 10 provinces. After the Second World War, agricultural production has increased impressively in the Netherlands. Also, many rural areas were subject to the so-called 'ruilverkaveling': land consolidation programmes resulting in larger agricultural lot sizes which were organized more efficiently as well as water discharge improvements by replacing winding streams with deep ditches. The latter resulted in a lowering of the water tables with 10 to 40 cm, sometimes even over 1 metre. This in turn enabled farmers to work with their machines on their lands even in wet periods. The most important cause for the fall in water tables is the extraction of groundwater for drinking water and industrial process water. The amount of drinking water abstracted rose from about 250 million m^3 in 1950 to more than 800 million m^3 at present. The amount of groundwater abstracted for industrial use was about 300 million m^3 in 1950, rising to about 500 million m^3 by the early 1970s and is currently 200 million m^3 (RIVM 2001). Lower ground water tables will cause the amount of nutrients in the soil to decrease, which is detrimental to the vegetation.

Map 2004/4 reveals that only very small parts of desiccated areas have been restored: a total of 15,000 hectares or 3% of all desiccated lands have been fully restored. This amount of restored desiccated land is only about 10% of the restoration goal originally formulated.

The Dutch summer of 2003 was a warm and dry one. Not only were water tables affected throughout the country, but also a peat dike in the village of Wilnis failed (Van Baars 2004). Many smaller dikes in the Netherlands consist of peat. Since peat has a relatively low specific weight, a peat dike has a higher risk of being pushed aside by water pressure. This threat becomes more realistic when water tables drop in dry periods – peat contains a large amount of water and organic materials. When peat dries out, the normal specific weight of peat will drop to much lower levels. The chances that the peat dike is then pushed aside because of the water pressure on one side are indeed very high. In Wilnis, the dike failure caused the canal water to run in a neighbourhood. The 600 houses quickly experienced a water level of half a metre; the 2000 residents were evacuated. It turned out that already in 1993 it was reported that this part of the dike was at risk. The two responsible public authorities – the province and the water board – only took measurements after the dike failure (Van Baars 2004). Many see this as another illustration of the fact that public water management is still not organized and coordinated efficiently enough.

MONEY AS WATER

A well-known Dutch saying is "to earn (or have) money as water", which means that a person earns or has large amounts of money – just as the Netherlands receives or has large amounts of water. Unfortunately, these large amounts of water bring costs to the society at large. The combined effect of the threats mentioned at the beginning of this text – rising sea levels, dropping land levels, changes in the seasonal amounts of water entering the country – as well as the as yet unsatisfied high aspiration levels in many aspects of water quality, necessitate that large amounts of money be made available for water management projects in the 21st century. In other words, it seems the Dutch must have "money as water" in order to combat that water successfully in the near future.

In 1998, the costs of public water management by the national government, the provinces and the municipalities amounted to over € 3,000 million, or 1% of the Dutch national income. Roughly 15% of this figure is spent on flood protection, 20% on water quantity measures and 65% on water quality measures (Huisman 2002). Half of the expenditures are made by water boards, 25% by municipalities and 20% by the national government. The remaining 5% of the costs are for the provinces. Huisman (2002) has published an interesting breakdown of the financing of the public water management, which we have reproduced here in a slightly altered version (Table 1).

Table 1. Financing of public water management in the Netherlands, 1998: relative shares in total expenditure of € 3,173 million. Based on Huisman (2002).

paying principle	national government	provinces	waterboards	municipalities	total
general budget	19.4 %	4.4 %		6.8 %	30.6 %
water board tax			17.6 %		17.6 %
ground water tax		0.3 %			0.3 %
pollution tax	1.1 %	1.0 %	29.1 %		31.2 %
sewerage tax				20.3 %	20.3 %

These figures make clear that close to 70% of the costs of public water management are raised by means of (predominantly) direct taxes to residents and firms. The taxes that inhabitants pay to water boards have, however, increased strongly over the last years – reflecting the increasing expenditures necessary for the tasks of water quality, water quantity and flood control (cf. Map 2004/2 for the regional variations in water board taxes). It has been calculated, however, that the collection of the various taxes by water boards can be done more efficiently. Also, public participation in the elections for the boards of management of the water boards is disappointing low: only 25% of the voters take the trouble to cast their vote (Stiphout 2003). It seems that the public at large is not that interested in the specific water management role that water boards play in their region.

In the summer of 2003, the so-called National Water Government Agreement ('Nationaal Bestuursakkoord Water') was signed. This agreement between national government, provinces, municipalities and water boards contains a 'deltaplan', indicating how the Netherlands should deal with the increasing threats and challenges in water management in the 21st century. The measures proposed in this agreement amount to € 16,000 million – and it is inevitable that residents and firms throughout the country will be confronted with a strong increase in the taxes they have to pay locally to water boards, municipalities and provinces in order to achieve the necessary measures.

It is clear that the major challenge in water management in the Netherlands in the next decades will be a financial one. Technically, the Dutch can deal with rising water levels and the effects of changing seasonal precipitation. The publication of the National Water Government Agreement in 2003 was also a major step forwards in integrating water management into the policy fields of physical planning, environmental planning and economic planning. From an economic point of view, the spending of a larger share of national income on flood control, water quality improvement and water quantity issues seems justified. More and more, cost-benefit analysis is implemented which shows that the economy as a whole as well as specific sectors (e.g., agriculture) in the long run benefit from increased investments in water management projects. But will it be possible to convince residents and firms to pay substantially higher amounts for measures that are necessary for both protective reasons as well as a continued unconditioned delivery of the right amounts of water in the right quality at the right time? Although both the profit principle as well as the polluter-pay principle have been accepted more and more in the Netherlands in the past decade, collecting much higher amounts of money from Dutch inhabitants seems to be a major challenge.

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