

Coastal Regeneration at Llanelli, South Wales, UK: Lessons not Learned

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ABSTRACT

PHILLIPS, M.R., POWELL, V.A. AND DUCK, R.W., 2009. Coastal regeneration at Llanelli, South Wales, UK: lessons not learned. *Journal of Coastal Research*, SI 56 (Proceedings of the 10th International Coastal Symposium), 1276 – 1280. Lisbon, Portugal, ISSN 0749-0258.

Following industrial decline, much of the South Wales coastline is undergoing regeneration and water frontage is the development focus. The construction of the Millennium Park, Millennium Coastal Path and Earth Structure at Llanelli, South Wales, UK stimulated a commercial and domestic property redevelopment strategy. However, this took place without due consideration of coastal processes and location. Furthermore, because of previous dereliction and lack of valuable infrastructure, temporal coastal data had not been collected as part of strategic monitoring. Consequently, following storm events the coastal path suffered catastrophic failure, the Earth Structure suffered erosion and significant damage became apparent on many newly constructed homes. Existing seawalls were undermined and required rock armour protection and their ability to protect recent developments is now in question. Causes and effects included inappropriate siting of infrastructure, advancing the line without due consideration of coastal processes and relocation of nearshore river channels. Lessons had not been learned following similar construction patterns elsewhere. Existing coastal defences and annual maintenance spending are both shown to be inadequate and inappropriate dredging practices are removing sediment from the system. This has serious repercussions for the coastal protection authority, not least as a result of threats to further development phases and legal repercussions. Strategies are suggested for long term management along the full coastal frontage, including financial implications of not strengthening coastal defences.

ADDITIONAL INDEX WORDS: *Coastal Defence, Erosion, Failure.*

INTRODUCTION

Llanelli's beach is surrounded by decommissioned industrial sites, docklands and part of Llanelli town (Figure 1). Past industries included agriculture, wool and pottery, ironworks, steelworks, tinplate, copper smelting and coal and lead mining. Transport systems were built around these industries with additional roads, tramways, railways, canals and docks developed in conjunction with economic growth. Llanelli docks became important and in 1834 large coal exports led to the construction of New Dock. Shipbuilding began in 1860 and North Dock was subsequently constructed to provide larger ship facilities (REES, 2006). When industry declined thousands of jobs were lost, leaving Llanelli as a town with high unemployment and an unattractive prospect for future employers. The docks fell into disrepair and land was unusable due to high amounts of contaminants which came from various local power stations, metal industries and mining.

With funding from the National Lottery, Carmarthenshire County Council and the Welsh Assembly Government, >800Ha (2000 acres) of contaminated industrial wasteland were converted into the Millennium Coastal Park (MCP). The development objective was to improve the region's housing, commercial accommodation and recreational facilities and included provision of the 22km Millennium Coastal Path (CCCESCTFG, 2007a). There

are 75,000 people living in the surrounding areas (BBC, 2004a) and in 2004, the area received over 500,000 tourists (BBC, 2004b). However, commercial and residential opportunities in coastal locations have led to increased infrastructure along the edge of beaches (JEDRZEJCZAK, 2004). This in turn has created a need for coastal defences to protect facilities. A fifth of the enlarged EU coastline is currently severely affected by erosion (EUROPA, 2007a). Of the 875km of European coastline that began eroding in the last twenty years, 63% is within 30km of areas altered by new engineering works (EUROPA, 2007b). Llanelli's coastline had not been extensively studied due to its past contaminated status and poor recreational facilities. Post-development problems are causing concern and there are additional pressures on sea defences. Therefore this paper will assess Llanelli's regeneration strategy, identify current and future threats and present future management strategies.

PHYSICAL BACKGROUND

The geology of Llanelli and environs is from the Carboniferous and Quaternary periods while the extensive coastal floodplains are dated within the Holocene (BOWEN, 1980). The area is of both national and international conservation importance and has been designated a National Nature Reserve (NNR), a Site of Special Scientific Interest (SSSI), an Area of Outstanding Natural Beauty



Figure 1. Location Plan

(AONB), a RAMSAR site, a Special Protection Area (SPA), a Special Area of Conservation (SAC) and there are two Local Nature Reserves (LNR) (WETLANDS INTERNATIONAL, 2005). The Burry Inlet is a RAMSAR site and lies between Llanelli, Burry Port and the northern edge of the Gower Peninsula (Figure 2). Since medieval times there have been considerable changes to coastal morphology and some of the land is only kept dry by seawalls prompted by coastline change. Because of human errors it is hard to ascertain through cartography whether there have been recent local accretional or erosional patterns (JAMES, 2006). The area has a spring tidal range of 8m and the predominantly southwest facing coastline is characterised either by low-lying wetlands straddling tidal rivers, or fronted by sand dunes (CBCEG, 1999). The combination of storm surges and high tides can cause inundation well above the reach of normal tides while these coastal lowlands have been subjected to intensive and dramatic landuse change (JAMES, 2006).

Coastal threats include sea-level rise, channelisation, sedimentation, erosion, species reduction, habitat loss and fragmentation (WETLANDS INTERNATIONAL, 2005). Seawalls, groynes and beach nourishment currently protect existing and new developments, including an important rail link, while Llanelli beach has a sandy foreshore that attracts tourists. The seawall has been locally undermined resulting in the addition of rock armour (CCCESC, 2004) while Burry Port has two westward groynes to prohibit sand movement (LLANELLI STAR, 2006).

The MCP (Figure 3) gives views over the Burry Inlet and Gower Peninsula (Figure 2). Pulverised Fuel Ash (PFA) was used for ground remediation, landscaping, engineering fill for bridges

and lime cement for roads (UKQAA, 2003). The Earth Sculpture, 'Walking with the Sea', was formed from PFA and highlights environmental benefits of reuse rather than disposal. It incorporated newly constructed beaches on its western and eastern flanks and the sculpture was designed to be seen from land, sea and air. Silt from Burry Port Harbour and sewage sludge facilitated rapid natural re-vegetation (UKQAA, 2003). It is located on the coastal path between Burry Port and Llanelli (Figure 3) and this coastal section previously had no hard defences.

Current land-use includes research and education, recreation, habitat conservation, bait collection, commercial and sport fishing, shellfish, grazing, sewage treatment and disposal, tourism and flood control (WETLANDS INTERNATIONAL, 2005). It is surrounded by new housing, and seafront flats such as the Millennium Quay (Figure 3), have been sited at Llanelli Beach. High-quality housing has been constructed on floodplains to the east and further housing and office buildings have been located around the path. The coastal park and surrounding area have been protected through the County Council's planning system and the Unitary Development Plan (UDP) is sympathetic to the MCP vision.

POST CONSTRUCTION PROBLEMS

Burry Port (Figure 3) has a busy recreational harbour that needs storm protection and a clear navigation channel for entry. There are two beaches, one to the east and one to the west of the harbour. The eastern beach is eroding while West Beach, backed by extensive sand dunes and short seawall, is relatively stable. Longshore eastward sediment transport (CBCEG, 1999) is interrupted by groynes and a seawall directly west of the harbour mouth. These cause sand bars which subsequently block the entrance (JAMES, 2006). A combination of sea and land dredging removes this sediment from the system (CCCESCTFG,

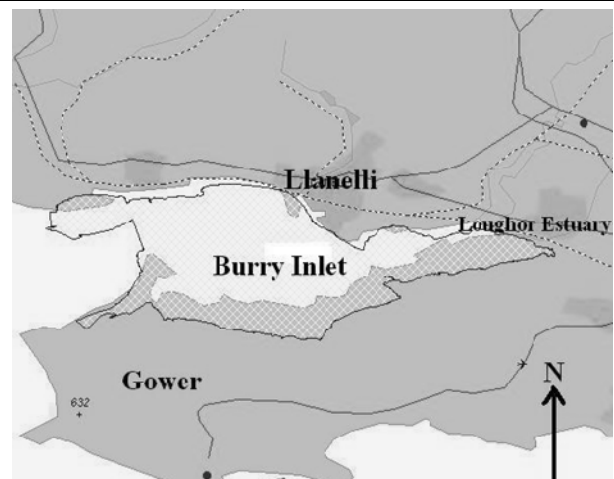


Figure 2. Burry Inlet RAMSAR site (WETLANDS INTERNATIONAL, 2005).

2007a) to the detriment of the adjacent coastline. The coastline immediately east is significantly affected by this loss. Figure 4 shows the impacts on the coastal path following a severe storm in March 2007. Prior to its construction, the beach was several metres seaward of the path, which illustrates the volatile and unpredictable nature of this coastline. It has subsequently been protected by rock armour to reduce further storm impact.

The Earth Sculpture (Figure 3) experiences westward river currents and eastward sea currents. The design meant it protrudes from surrounding land into the sea, making it vulnerable to attack. Since its construction the structure has eroded but is not yet irreversibly compromised. The newly constructed beach to the east shows evidence of erosion with PFA appearing as black streaks on the sand. On completion there had been gentle gradients from the hinterland onto the beach but these are now steep and the beach has increased in width. On the western flank, there are sections that have >2m drop onto the beach. In that March 2007 storm, sections near the Earth Sculpture retreated by 10m (CCCESCTFG, 2007a; CCCESCTFG, 2007b). Concrete fence posts erected to prevent people falling over an ever increasing cliff edge, now lie at intervals along the beach, some 2m from the sculpture base. There is evidence that the naturalness of this site is starting to be compromised by rock revetments constructed to protect the coastline. However, if this section was allowed to retreat then more of the coastal path would be lost.



Figure 3. Millennium Coastal Park

The seawall at Llanelli is approximately 2km long and joins the southeast dune system. Llanelli and Burry Port both have structures restricting sand movement which impacts the coastline (LLANELLI STAR, 2006). The dune system is the only sustainable part of Llanelli Beach and falling sand levels front the seawall. Consequently it has suffered storm damage and rock armour has been placed to protect the base. As the seawall integrates with the dune system sand levels rapidly increase. Pollution, including ruptures in sewage lines, contaminated Llanelli Beach and surrounding areas (BBC, 2005a; LLANELLI STAR, 2005a). This

caused restrictions for visitors and destruction of adjacent cockle beds (SWEP, 2005; BBC, 2005b) worth £6M in revenue to the local economy (SWEP, 2005b).

Llanelli's redevelopment removed industrial ruins and provided a flat complex behind the beach for residential and commercial development, the nearest located within 8m of the seawall (Figure 5). However, severe storms are endangering these homes (SWEP, 2007), including when Millennium Quays (Figures 3 and 5) lost part of its roofs, forcing evacuation of new residents (LLANELLI STAR, 2005b). The necessity for a roof design change half way through construction highlights poor design considerations for this shore-side development. The MCP was hit by severe high tides and storms in both March 2006 and March 2007, which led to considerable seawall and promenade damage (Figure 5; CCCESCTFG, 2007a).

DISCUSSION

The Welsh Assembly Government's (WAG) coastal erosion policy is to economically and sustainably reduce risks to people and the environment. Although ultimately responsible for flood and coastal defence, these have been delegated to various organisations, including local authorities and the Environment Agency (EA) (CCCEEDD, 2002). Although the EA was consulted about flooding issues during the MCP planning stage, neither it, nor respective local authorities were further involved (CCCESCTFG, 2007a).

The Millennium Commission and National Lottery funded the MCP construction and the former included a clause that the path must be maintained and remain in place for 75 years. Consequently if the path is lost, construction costs would have to be repaid (CCCESCTFG, 2007a). Recently, costs to repair defences between Llanelli and Burry Port were estimated at between £15 and £20M (WALES ON SUNDAY, 2004), which would be spent on building higher seawalls (CCCESCTFG, 2004). However, only £50,000 was spent between 1994 and 2004 inclusive, on coastal protection and maintenance (BBC 2004a; CCCESC, 2004). In 2006/2007, Llanelli and Burry Port received a joint budget of £75,000 for sea defence repair and although up from £17,000 the previous year, it was not enough and damage repairs used the entire budget within the first month (CCCESCTFG, 2007a). An additional combined budget of £47,550 was given to fill and repair coastal defences and the earth sculpture toe, but the local authority wanted this doubled for storm protection and emergency contingency funding (CCCESCTFG, 2006). In 2007 following severe storms, WAG and Carmarthenshire County Council gave £83,000 and £400,000 respectively to repair Llanelli's seawall (CCCESCTFG, 2007a).

It is important for all coastal professionals to understand causes and consequences of coastal erosion and flooding. This includes sea level rise, global warming, natural and anthropogenic land changes, reduction of river sediment supply and increased coastal development (DOORNKAMP, 1998; COUDERT, 2005). Previously, insurance has been used as a financial flood defence which due to increasing coastal risk, may not be a future option. Positive steps towards hazard identification and prevention need to be included as part of competent beach management plans (DOORNKAMP, 1998). STAMSKI (2005) suggested that a long-term regional-scale erosion response and armouring plan be developed to predict erosion hotspots. This would reduce the need for emergency works and increase defence suitability. Investigations would identify weakened structures and alert management to defence needs with additional time to acquire capital. Llanelli Beach, the Earth Sculpture and Burry Port harbour all have identified hotspots.

Infrastructure at Burry Port is defended with rock armour and coastal structures. Harbour defences result in sediment loss from the system and continuation of current practices will result in further adjacent beach depletion. Therefore it is suggested that dredged material from the harbour channel is used to recharge beaches to the east. This will be compatible with the size of material already on the beach, a sustainability requirement identified by CIPRIANNI *et al.* (1999) and MICALLEF *et al.* (2001). Furthermore, the originally planned flushing lock gates should be installed to reduce dredging costs and sediment losses. The low-lying coastal path is too close to the sea and original design problems are accentuated during storms. Its location should have been higher and further from the coastline and if it is not moved, further failure, as shown in Figure 4, is inevitable. In the short term, maintenance and observation regimes are needed to protect the path (CCCESCTFG, 2007a).

The Earth Sculpture needs both structural and aesthetic protection. Despite treatment, the land may still contain contaminants and current erosion rates are exposing PFA layers used as landscaping material. From a large-scale perspective, if the land had not been modified to form the MCP then no contaminants would have been treated. However, the Earth Sculpture shoreline has been extended into the sea and coastal processes do not support its location. Direct and refracted wave attacks combined with strong estuary currents are eroding the sculpture from both west and east. Protection and/or sediment recharge needs detailed consideration, including sediment size/material and allowable retreat rates. Current management has discreetly placed small gabion cages and igneous rock but should consider future retention of shape and naturalness.

Siltation of the Loughor Estuary (Figure 2) after the collapse of training walls further up river caused movement of the nearshore channel and since 1970, has caused considerable damage to Llanelli beach. Any future management plans would need an assessment of the nearshore channel's movement. The March 2008 storm event detached sections of the main dune formation and distributed them along the beach. The dunes were not greatly impacted by this loss which protected part of the seawall. Currently Llanelli beach has many hard engineering structures that are incapable of total storm protection. In 2001, these defences protected up to £5M of assets from erosion and flooding, but risk increases as new housing is built. Defences in place before the MCP development now protect further infrastructure (Figure 5). Additional armour and sediment have been used to protect the seawall base from undercutting, which is not uncommon (SIMM, 1996). It is traditional for Anglo-Welsh coastlines to manage through hard-engineering holding-the-line practices (TURNER *et al.*, 2007), but tourists and ecologists prefer a more natural soft-engineered approach (ERGIN *et al.*, 2006; TUDOR AND WILLIAMS, 2006). It would no longer be practical to remove Llanelli's seawall especially due to the height difference between the promenade and foreshore. The majority of the seawall is >3m above the foreshore and near the railway line, reaches a maximum height of 3.92m. This height variance suggests the foreshore needs to be higher. By covering the base of the seawall with igneous rocks, wave impacts are reduced but for effective protection, greater volumes are needed.

The lack of financial backing has left Llanelli's coastal defences inadequate and the local authority has to choose the least expensive instead of the most effective long-term option. Economic land values have increased since redevelopment and it has been suggested that any land sold for coastal development should include a financial contribution for improving sea defences (CCCESCTFG, 2007a). If such finance was available, further sandy



Figure 4. Coastal path failure



Figure 5. Promenade post March 2008 storm

beaches may be developed (CCCESC, 2004). Funding is a major issue and the coastal path may be lost if this is not addressed (CCCESC, 2006). Irrespective of the social justice issue (COOPER AND MCKENNA, 2008); it would be disastrous for a local authority unable to afford its loss.

CONCLUSIONS

Following industrial decline, the construction of the Millennium Park, Millennium Coastal Path and Earth Structure at Llanelli, South Wales, UK stimulated a commercial and domestic property redevelopment strategy. Following storm events a section of the newly constructed coastal path suffered catastrophic failure, the Earth Structure suffered erosion and significant damage became apparent on many newly constructed homes. Furthermore, existing seawalls were undermined and required rock armour protection. Causes and effects included inappropriate siting of infrastructure, advancing the line without due consideration of coastal processes and relocation of nearshore river channels. Existing coastal defences and annual maintenance spending are both shown to be inadequate and inappropriate dredging practices are removing sediment from the system. Strategies suggested for long term management include restoring longshore sediment movement, relocating the coastal path, soft engineering protection to the Earth Sculpture and rock armour protection to existing seawalls.

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