River Delta Evolution, Water Volume Distribution, and Flood Tide Channel Formation in the St. Jean Estuary, Gaspe Quebec

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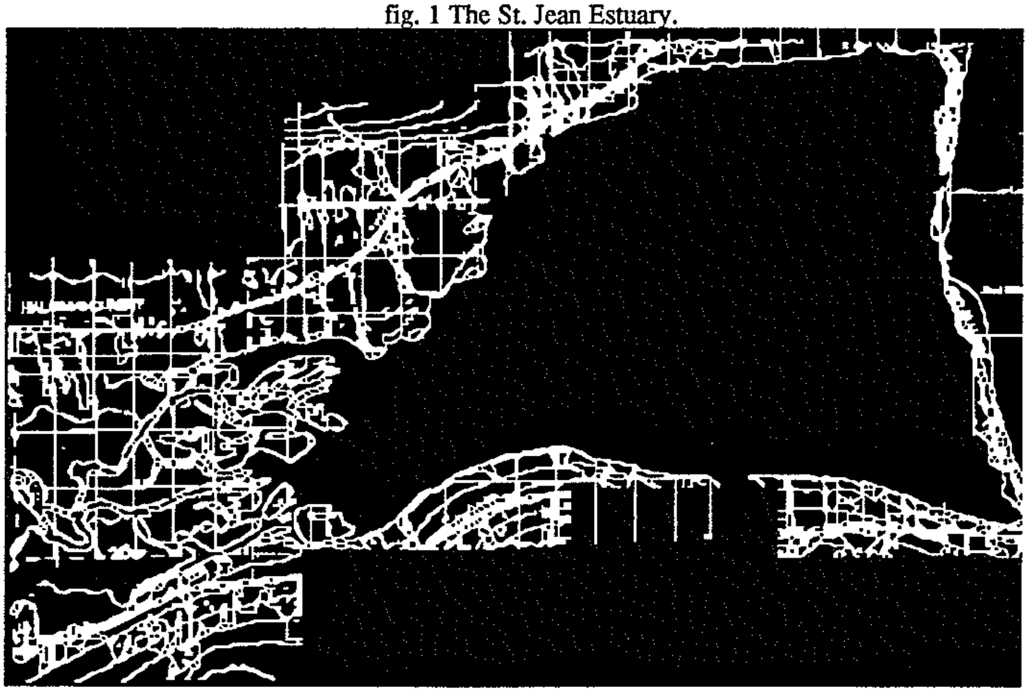
Introduction

The St. Jean River drains much of the Gaspe Peninsula in south eastern Quebec. It is a shallow river, with a width of about fifty meters. The river drains into the St. Jean Estuary located on the south eastern shore of the Bay of Gaspe. The estuary takes up an area of about 5.5 km^2 (Figure 1)

The area has been subject to change due to flooding of the St. Jean River, and the migration of the mouth of the estuary along the Hamilton and Douglastown Spits. Both sediment distribution and debris dam formation are partially a function of river delta evolution and periodic flooding. Flood tide channel position is linked to migration of the estuary mouth along the two spits.

fig. 1 The St. Jean Estuary.



Methods

Water discharge along the St. Jean and its main delta channels were measured to give an estimate of the amount of water the fresh water system was contributing. A Price-AA water current meter was used in these fresh water measurements.

For tidal height fluctuations at the back and north central part of the estuary, two stilling wells were set up, and equipped with Stevens well recorders.

Aerial photographs from 1942, 1961, 1962, 1976, and 1992 were all used to determine evolutionary processes within the estuary. These aerial photos were scanned into a Macintosh computer, then manipulated and studied with Canvas 3.05 (Deneba Software, 1991).

Results

The river delta changing through time is mainly due to sediment distribution and debris dam formation. The main flow channel itself, has moved several times from 1948 to present. Sediment distribution in the form of sand bar growth, tracks progression of delta flow.

Figure 3 : map of marsh zonation

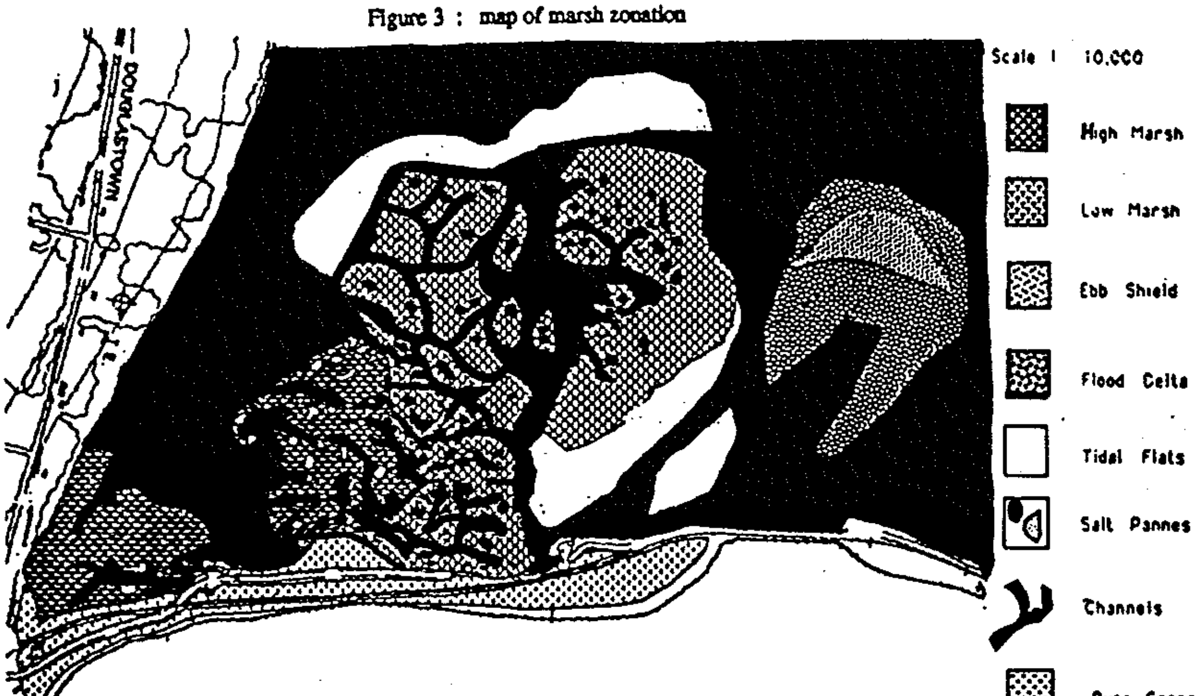
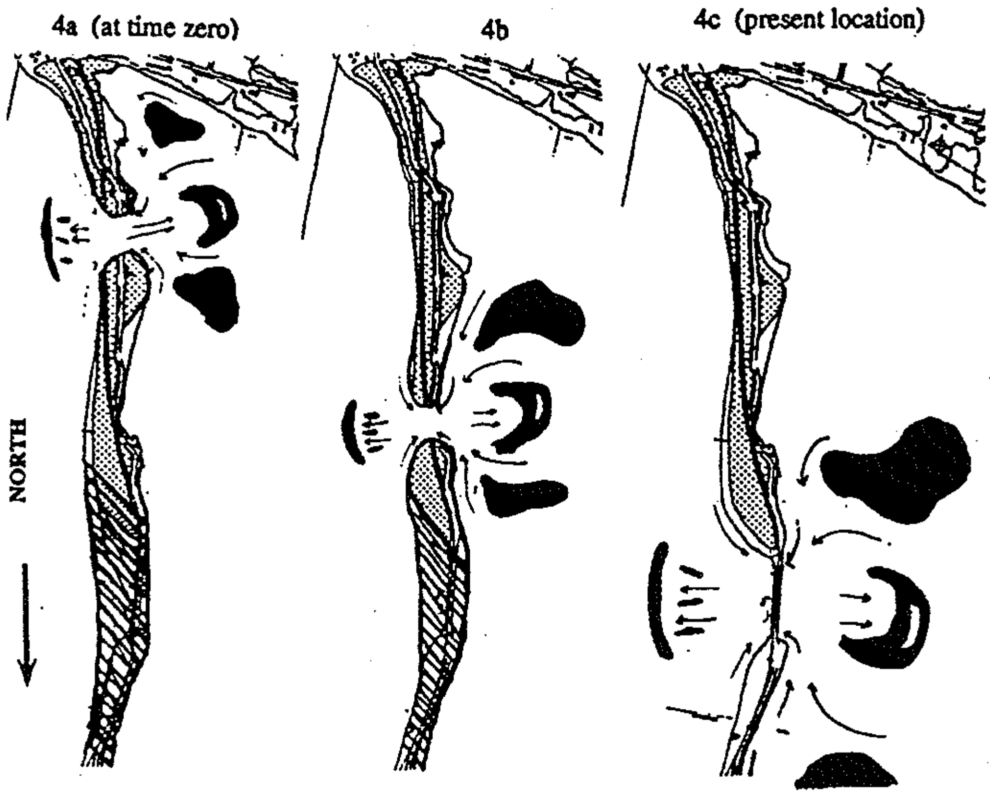


Figure 4 : Simple model illustrating the northerly migration of the inlet. Figure 4a is at time zero, figure 4c is at the inlet's present location. (scale 1 : 10,000)



In 1948, the major portion of the St. Jean River's discharge was heading through the northern channel. This area was then cut off by sediment deposits and debris dams in the form of huge logs. This forced the major portion of flow to head down a central channel which led straight into the estuary , which can been seen in the 1962 photo (Figure 2).

By 1976, this central channel was completely filled with logs and sediment as well (Figure. 3). The main flow had then shifted to the two southern channels as evidenced by sand bar growth. There is some minute activity in the northern channels, as well.

Today the main flow channel is the south central channel (figure 4).
The southern and south central channels receive about 80% of the total discharge from the St. Jean. The northern channels have been reopened to about 20% of the rivers discharge.

The debris dams in the north have been growing, and seem to be migrating upstream (Figure 4). This is because the northern channels receive a majority of the water during flood conditions, thus getting a majority of the logs.

The flood tide position is a function of the migration of the estuaries mouth along the Douglastown and Haldiman Spits. Ron Connel (1992) reports that the mouth has migrated from the southern edge of the Douglastown Spit to its present position at the center of the two spits (Figure 1). Figure 5 illustrates the channels present position running along the southern edge of the estuary, and winding up to the mouth of the estuary. With the migrating channel mouth hypotheses, this shape for the channel would be a simple function of least resistance to flow. The original mouth would have caused the channel to run along the southern edge of the estuary. As the mouth migrated toward the north, the water would still find it easier to follow the old flood tide channel rather than dig a new one. The curving of the channel toward the north near the mouth is likely due to Coriolis effect as the tide comes in.

The volume distribution of the was grossly estimated using tidal height changes and discharge values. David Scholler form Williams College (1992) estimated the total volume to be around 7.1 million m^3 of water. The total amount of water circulating in an average tidal cycle is estimated to be around 2.5 million m^3 of water. The St. Jean river produces around 900,000 m^3 in the twelve and a half hour cycle. The remaining volume of water could partially be due to seep and streams emptying into the estuary. This would indicate that the river is accountable for about 40&% of the water influx during one tidal cycle. These estimates are very crude, however, and relative error may be high enough to make these values meaningless. The order of magnitude of the volumes seems to be somewhat accurate, however.

Discussion

To truly get a handle on the processes of the St. Jean Estuary, a great deal of further work must be done. The methods employed for measurements were somewhat crude, which leads to the question of how accurate these measurements are. Better equipment is the first thing that one must have to really do the job right, and also a more efficient way of getting around in the estuary to make the measurements.

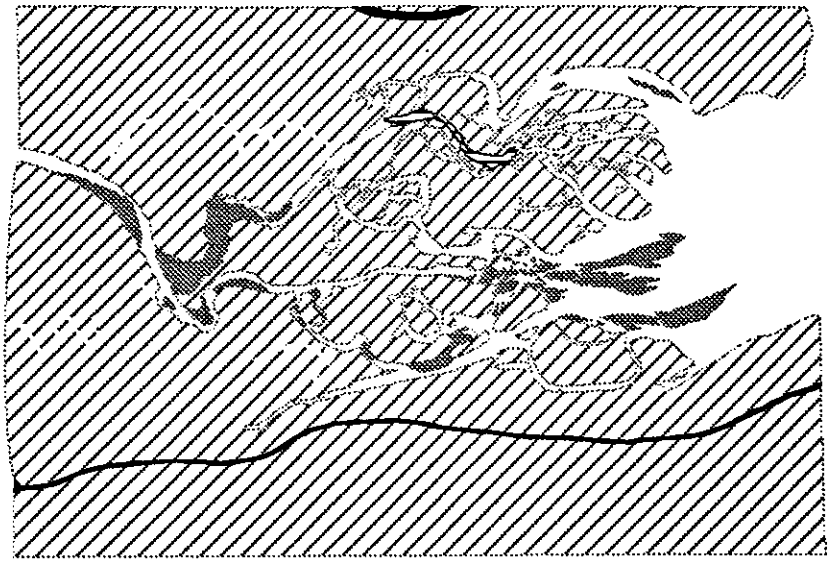


fig. 2 The river delta in 1962, notice the central flow channel.

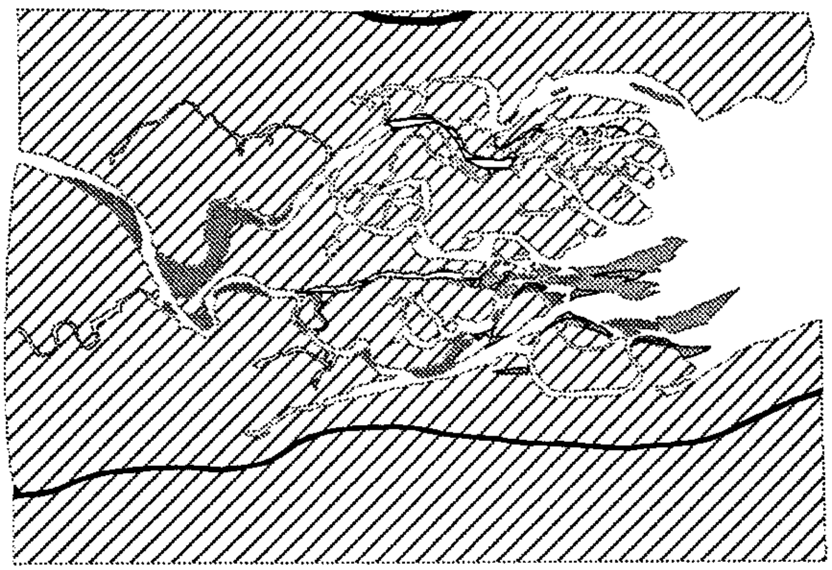


fig. 3 The river delta in 1976, central flow channel has now been completely filled in with debris.

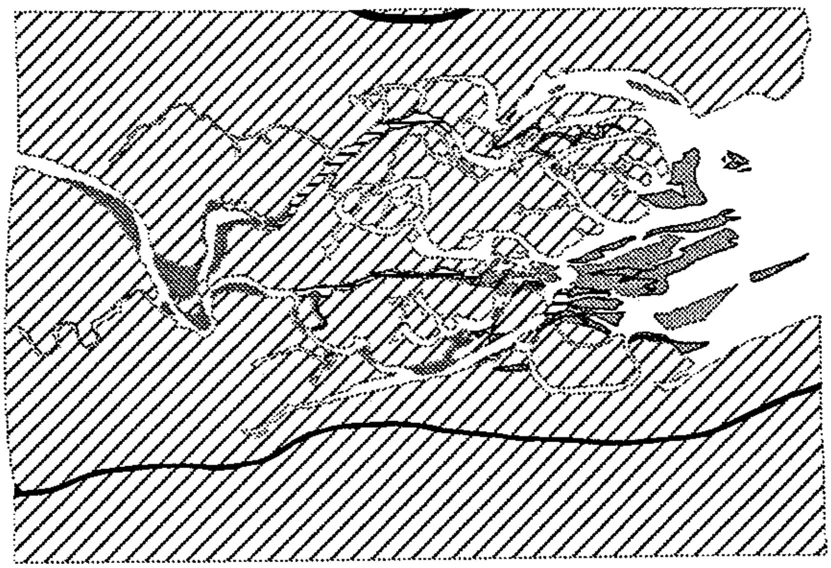


fig. 4 The modern river delta.

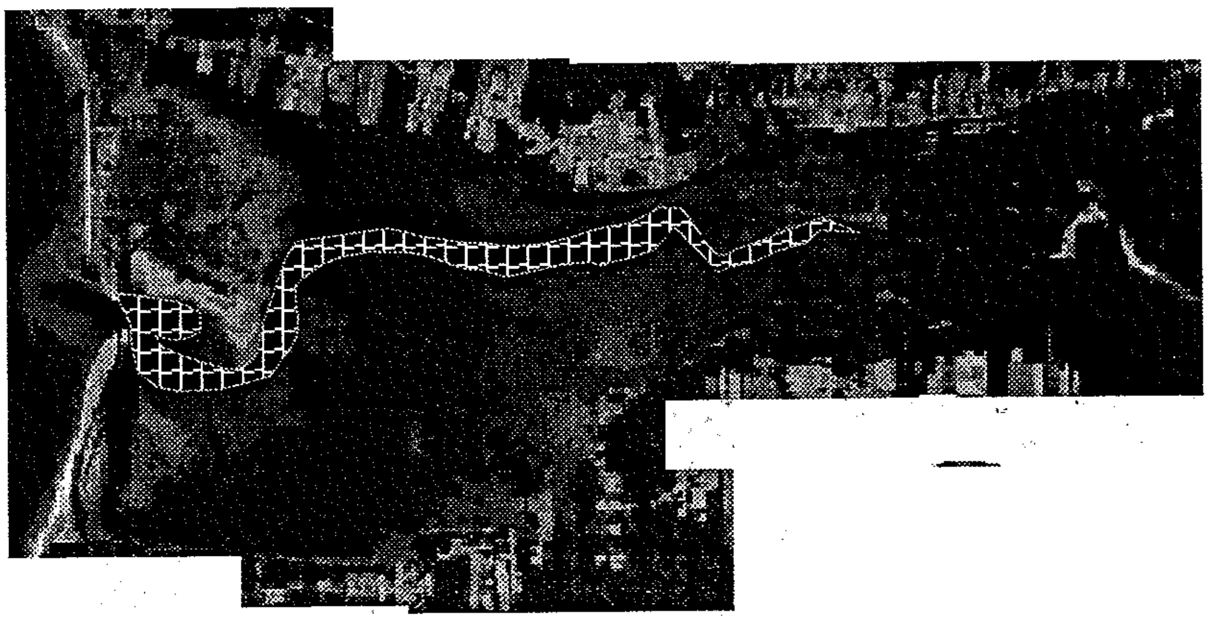


fig. 5 complete estuary image with highlighted flood tide channel

Evolution of the Ebb-Tidal Delta St. Jean Estuary Gaspe Peninsula, Quebec, Canada

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Introduction

Ebb and flood tidal deltas occur on the seaward and landward sides, respectively of an inlet between barrier spits of the St. Jean estuary Gaspe Bay, Quebec, Canada. The St. Jean estuary inlet is between the Douglastown and Halimand spits at the mouth of the estuary (Lenz, 1992). An accumulation of sediments deposited primarily by ebb tidal currents has created a conspicuous ebb tidal delta on the seaward side of the estuary mouth which is typical of such systems (Davis,1991). The shape and position of the ebb-tidal delta as well as the spits changes over time because of tidal and or longshore current influences. It is the goal of my research to describe the morphology of the ebb-tidal delta of the St. Jean estuary. My study focused on an area approximately 2,000 meters along the coast and up to 600 meters east into the seaward side of the estuary.

Methods

The primary method used in study of the morphology of the ebb-tidal delta was the comparison of air photographs that date back to 1948. Air photos taken in 1948, 1961, 1962, and 1976 were compared and contrasted at a scale of 1 in = 200 meters. Because air photographs were not available for years since 1976 a contour map was constructed using a laser theodolite to plot points used to form the contour map. The Surface III program for the Macintosh computer was used to construct the map. Oblique photographs were taken from a private airplane were used to constrain recent morphology. Spanning the inlet of the St. Jean estuary is a railroad bridge. This bridge, as well as the railroad itself, is often used as a reference point when comparing the air photos. In addition a contour map was constructed using a laser theodolite to plot points used to form the contour map. The Surface 3 program for the Macintosh computer was used to construct the map.

Results

The primary results of my field study are summarized by the topographic map of Fig. 1. To constrain topography 458 points were used. Analysis of the contour map revealed that in 1992 the main ebb channel turned north in a single channel that gradually decreased in depth. The terminal lobe of the estuary arcs around the main channel extending further north than the end of the channel. The arm like appearance of the terminal lobe is unprecedented suggesting substantial changes since 1976.

Discussion

A comparison of the map of Fig. 1 with air photos as far back as 1948, shows evolution of deltaic features including terminal lobes, sand bars and lateral channels as affected by northerly directed longshore currents and wave energy.

Ebb Channel

The main ebb channel in 1948 flowed slightly south eastward straight through the barrier island inlet with only a slight bearing to the south (Figure 2). By 1961 the main ebb channel had made a stronger shift to the south. The main channel extended out to a distance approximately 240 meters beyond the railroad bridge. By the following year the channel had lost some depth. This is evident in the fact that the greater depths of the main channel do not extend much farther that the bridge (only about 100 m). Drastic changes had occurred in the position and strength of the main ebb channel by 1976. In 1976 the main ebb flow was no longer contained in a single channel but instead branched into three channels (Fig. 2). The three channels tended southeast, east, and northeast, but the largest channel moved northeast, loosely following