This paper proposes a MIMO system where the base station (BS) acquires quantized phase-only (PO) measurements of the complex baseband signal by our introduced stage-wised phase quantizer. PO-MIMO requires only one-bit ADCs for data sampling, so it successfully overcomes the ADC bottleneck that appears when the signal bandwidth is extremely wide. We construct a PO generalized approximate message passing (POG-AMP) algorithm for solving the linear mixing problem with quantized or unquantized phase measurements. POG-AMP has low computational complexity, exploits the signal prior statistical distribution, and handles the nonlinear distortions exerted on the measurements (e.g., losing magnitude and quantization). Then, POG-AMP is successfully applied to construct practical channel estimator and multiuser detector for PO-MIMO. Numerical results show that the POG-AMP estimator (POG-AMPE) and POG-AMP detector (POG-AMPD) are robust to the phase-quantization loss. POG-AMPE acquires high-quality channel side information at the receiver (CSIR), and POG-AMPD is robust to the CSIR errors when the BS antennas are massive enough. By introducing moderately more BS antennas, PO-MIMO with phase measurements even performs similarly to MIMO with full measurements containing both magnitude and phase. In order to maximize the transmit energy-efficiency, the lengths of the channel training sequences should be gradually increased with the increase of the channel coherence time. Antenna correlations at the BS degrade the convergence and bit-error rate performances of POG-AMPD, but can be handled by the analog spatial filtering technique.